Understanding and Expanding the Role of Personal and Household Behavior in Climate Change Adaptation

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Environment and Sustainability)
in The University of Michigan
2020

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ACKNOWLEDGEMENTS

This dissertation came together only because I received support from many amazing people. First and foremost, I am so grateful to my advisor, Michaela Zint, whose support for me has been unwavering even through the most uncertain times, and who gave me both the freedom and the guidance to develop my tangle of ideas into real scholarship. I am also grateful to my dissertation committee members, Rosina Bierbaum, Richard Norton, and Kaitlin Raimi. Each of them has brought a different and incredibly valuable perspective that helped me make my work more interdisciplinary and more impactful. They have also all pushed me to better work while always being supportive and constructive. I also thank my past committee member, Victoria Campbell-Arvai, for her support and guidance through many ups and downs, and my past mentors, Raymond DeYoung and Larissa Larsen, who helped me navigate complex ideas early in my doctoral career.

I also thank other faculty members at SEAS and elsewhere at UM who have supported my graduate work, including Avik Basu, Jason Duvall, Inés Ibáñez, Maria Carmen Lemos, Thomas Princen, and Julia Wondolleck at SEAS, and Marie O'Neill at the School of Public Health. I'd also like to give special thanks to Bilal Butt for being the first person to suggest to me that I should think about pursuing a PhD, giving me the permission I didn't even know I needed to pursue my ideas.

Thanks to Rackham Graduate School, including the Rackham Program in Public Scholarship, and the Graham Sustainability Institute's Dow Doctoral Fellowship program for their financial support. I also am incredibly grateful for administrative support from SEAS'

administrative and business staff, as well as past associate deans Don Zak and Michael Moore during particularly rocky times on this journey.

I am grateful to many friends and colleagues who have provided feedback on these various chapters as they have been developed, including Dominic Bednar, Michael Lerner, Thomas Logan, Jessica Ostrow Michel, Timothy Williams, participants in the MUSE fall 2019 workshop, the Dow Doctoral Fellowship 2019 cohort, and members of my Rackham Dissertation Writing Group. I am especially grateful to Peter Siciliano and Hagan Capnerhurst (co-author on Chapter 4) for their research assistance. I also thank the adaptation professionals who participated in my interviews (Chapter 4) for their time and insights.

I am grateful to the community of SEAS doctoral students past and present and my fellow members of the Michigan University-wide Sustainability and Environment (MUSE) Initiative for their friendship, giving me space to workshop ideas, and for helping me expand my thinking in countless ways. Thanks to my family for their support and love, and thanks to my friends, both near and far, for providing a listening ear and helping me keep perspective.

Finally, my deepest thanks to my husband, Rich Bunnell. When I said I wanted to go to graduate school I know that neither of us anticipated that my work would take me in the directions it has. Thank you for your partnership and patience, your willingness to be a sounding board, and for always checking whether the scraps of paper around the house with my handwriting on them are important before recycling them. I'm grateful to be with you every day.

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ABSTRACT

Climate change is already affecting humans' day-to-day lives. Climate change threatens people's physical and mental health, where they can live, as well as their homes and communities. Many environmental hazards existed before climate change, but climate change has worsened many of these threats, particularly for people who are already experiencing other environmental stressors such as pollution and deteriorating infrastructure. Individuals will respond and are already responding to climate change impacts, but they may do so in a way that has immediate, personal benefits but harms their future selves, other people, or environmental quality.

This dissertation presents first steps for understanding personal and household climate change adaptation behavior, a topic which has not been deeply explored by researchers to date. *Personal and household adaptation behavior* refers to actions that individuals can take in their day-to-day lives to address the impacts of climate change on themselves and their households. My goals were to understand first, which specific behaviors might meet this definition, and second, how those behaviors might be supported. Rather than prescribe one behavior that all individuals should do, I explore what options are available and how an individual or organization can decide what behaviors are the best fit for what they want to achieve.

I identified eight major types of personal and household adaptation behavior that have been named in the literature: civic engagement, consumption, psychological coping, household protection, learning, lifestyle change, migration, and self-protection. These behaviors consist of

actions that one can take internally (i.e., coping, learning), actions that one can take for personal protection (i.e., household protection, self-protection, and migration), and actions to support social and environmental change (i.e., consumption, civic engagement, lifestyle change).

To determine what behaviors might be helpful, or *adaptive*, in responding to climate change, first, it is important to consider both what specific impacts are being addressed (e.g., flooding, heat waves, or drought) and what outcomes are desired (e.g., reducing household damage or increasing community cohesion). An adaptive behavior both responds to that specific impact and supports that desired outcome.

Organizations' activities to support individuals in taking on adaptive behaviors are called interventions. These interventions can change what opportunities are available for individuals to act (i.e., structural interventions), or activate factors related to an individual's motivation to act (i.e., informational interventions), or both (i.e., cross-cutting interventions). These potential interventions may take a variety of forms. In the U.S., these practices have included resilience hubs (structural interventions) virtual reality simulations of climate impacts (information interventions), and home flooding buyouts (cross-cutting interventions). Interviews with practitioners who conduct these interventions, however, revealed that many of them do not link their activities to behavior in an explicit or strategic way. As a result, adaptation behaviors researchers and practitioners are missing key insights from each other's work.

This dissertation represents an important first step in understanding personal and household behavior and lays groundwork for expanding its role in adaptation research and practice. Based on this research, future scholars will be able to better measure both what adaptation behaviors individuals are carrying out, and how those behaviors might change, so that individuals and communities can survive and thrive in the face of climate change.

CHAPTER 1

Introduction

Climate change is here. It is directly linked to increased likelihood of short-term events like extreme rain events, flooding, hurricanes, and heat waves, and long-term changes like sea level rise, droughts, changes in seasonality, and indirectly linked to impacts such as changes in disease vectors, water supplies, and food availability (IPCC, 2014, 2018; USGCRP, 2018). These climate change impacts have and will continue to have profound effects on the day-to-day lives of individuals around the world, so there is a need to understand what individuals can do to respond to them.

In this dissertation, I present a definition and framework for what I have termed *personal and household climate change adaptation behavior*. The Intergovernmental Panel on Climate Change (IPCC) report defines climate change adaptation in human systems as "the process of adjustment to actual or expected climate and its effects … to moderate or avoid harm or exploit beneficial opportunities" (IPCC, 2014, p. 118). The term *adaptation* is often used in contrast with *mitigation*, which refers to strategies to reduce the amount of greenhouse gases in the atmosphere (IPCC, 2014). Adaptation and mitigation are sometimes treated as competitive or even mutually exclusive, even though research has found that individuals do not necessarily perceive them that way (Carrico et al., 2015). I use the conceptualization of adaptation as "managing the unavoidable" impacts of climate change and mitigation as "avoiding the unmanageable" (SEG, 2007, p. ix) to think about how these two concepts fit together. Mitigation remains critically important, but climate change impacts are now inevitable, and in many places

are already occurring, so adaptation is necessary but should avoid strategies that worsen future climate change impacts (IPCC, 2018).

Adaptation is also a scientific term, used in both biology and psychology to describe the natural process by which an organism changes to better fit within their surrounding environment. In biology, adaptation generally occurs across individuals over generations, but in psychology, adaptation also occurs within individuals as they internally adjust to changes and disruptions in their lives (Swim et al., 2009). In humans, the process of psychological adaptation also includes the process of coping, or managing external and internal pressures on one's cognitive and emotional resources (Swim et al., 2009). The definition of *adaptation* that I use draws primarily on the IPCC's definition but is also influenced by the psychological definition, examining how individuals adjust to short- and long-term impacts of climate change in their day-to-day lives.

I use *behavior* to refer to actions that individuals take alone or with others, rather than the behavior of organizations, governments, or non-human actors. Research on behavior in the context of addressing environmental problems (i.e., pro-environmental behavior) has often defined behavior as consumer actions, namely household actions involving purchasing or consuming goods to reduce resource consumption or pollution (e.g., Dietz et al., 2009; Osbaldiston & Schott, 2012). Many campaigns to promote pro-environmental behavior have focused on these consumer actions, but they are not the only kinds of behavior that are possible. Pro-environmental behaviors can also include political actions such as advocacy (Levy & Zint, 2013), and in recent years research has emerged on sustainable lifestyles or lifestyle change, which promote longer-term, farther-reaching changes to one's overall way of living (e.g., Capstick et al., 2014)

All of these types of behavior focus on reducing humans' negative impact on natural systems, but focusing on only reducing environmental harm is no longer a sufficient goal for human behavior and behavior research. Significant environmental changes are already occurring and will continue to occur over the coming decades, and will have particular negative impacts on individuals in poverty, people of color, and those who live in areas with existing environmental problems (IPCC, 2014, 2018; USGCRP, 2018). Therefore, my goal was to understand what kinds of behavior could help people survive and thrive in the face of those changes, without causing further harm to natural systems or other humans. This led me to explore what behaviors supported climate change adaptation. As I will discuss, I found that many researchers had examined different types of behavior that supported adaptation, but the research went in many different directions that often did not clearly connect with each other.

Moreover, research from the field of climate change adaptation has rarely integrated behavior in an intentional way. Though adaptation researchers acknowledge that human behavior varies and can support or undermine adaptation plans (e.g., Adger et al., 2009; Fazey et al., 2010), relatively little research explored what, exactly, individuals could do to support adaptation or how those behaviors might come about. Behavior change research offers several decades worth of insights about what individuals can do and why individuals act on environmental issues (M. J. Stern, 2018), but many of those insights had not been applied in the area of climate change adaptation.

Therefore, my goal was to bring together research on climate change adaptation and research on human behavior to lay groundwork for understanding personal and household adaptation behavior as an emerging field of social research on climate change. The term *personal and household behaviors* refers to actions that individuals can take in their household as part of

their day-to-day lives, rather than as a part of professional or livelihood decision-making, and is thus analogous to residential behaviors from demand-side management research (as contrasted with non-residential behaviors; Van Raaij & Verhallen, 1983) but inclusive of actions such as political action or psychological coping. These kinds of behaviors can occur in rural settings, but my work does not include the kinds of behaviors that are exclusive to those settings, such as farming practices like changing crops (e.g., Feola et al., 2015). Research to date has not distinguished between personal and household adaptation behavior and farming or resource management adaptation behavior (e.g., Lee & Davis, 2019; van Valkengoed & Steg, 2019a; Wilson et al., 2020).

I focus on personal and household behaviors so to identify actions that are possible for the greatest amount of people to carry out. Climate change will impact and is already impacting farming, resource management, and livelihoods (IPCC, 2014, 2018), and the extensive research in those areas remains critically important (e.g., Feola et al., 2015; Fischer, 2019). However, focusing only on these areas provides no guidance for what individuals outside of them – including individuals who live in urban areas, who make up more than half of the world's population (UN DESA, 2018) – can do to adapt to climate change. My research helps address this knowledge gap.

The purpose of this dissertation is not to provide a final, definitive understanding of the concept of personal and household adaptation behavior, but instead to lay the groundwork for future research and practice in this area. I do so in three research-based chapters and one concluding chapter. In Chapter 2, "Defining and classifying personal and household adaptation behaviors," I present results from a systematic literature review to understand how researchers from multiple disciplines have defined personal and household adaptation behaviors, and what

kinds of behaviors meet this definition. In Chapter 3, "Bridging theory and practice to support personal and household adaptation behaviors," I present a synthesized theoretical model and typology of potential interventions related to personal and household behavior, with a focus on interventions used in urban settings in the United States. In Chapter 4, "Implementing climate change adaptation behavior change programs: Insights from practitioners in the United States," I present results from 29 semi-structured interviews with adaptation professionals, where I use the framework and typology from Chapter 3 to analyze current practice to support adaptation behaviors in the United States. The geographic focus also narrows in each chapter, with Chapter 2 focusing globally, Chapter 3 focusing on industrialized nations, and Chapter 4 focusing exclusively on the U.S. In the conclusion (Chapter 5), I summarize the key takeaways and new contributions from this dissertation and offer future directions for research on this topic.

CHAPTER 2

Defining and Classifying Personal and Household Adaptation Behaviors[1]

With climate change increasingly affecting individuals' day-to-day lives, interest is growing in the personal and household adaptation behaviors that people can engage in. Many of these behaviors focus on actions to protect oneself or one's household in response to immediate hazards rather than ones that may achieve longer-term adaptation goals. We conducted a content analysis of 75 publications identified through a systematic literature review to learn how researchers from a range of disciplines conceptualize adaptive behavior in the context of climate change and what kinds of specific actions they describe. Based on this review, we propose a comprehensive definition of personal and household adaptation behavior that considers its purpose (i.e., preventing harm or gaining benefits), timing (i.e., proactive or reactive), time scale (i.e., short-term or long-term), as well as who acts (i.e., the individual alone or with others) and who is affected by those actions (i.e., the individual, other people, or the environment). We classify specific individual adaptation behaviors into civic engagement, consumption, coping, household protection, learning, lifestyle changes, migration, and self-protection. Research is needed to better understand the personal and societal benefits of adaptation behaviors and how to support these actions more equitably in different contexts.

[1] A version of this chapter was previously published in the journal *Global Environmental Change* with the following citation:
Carman, J. & Zint, M. (2020). Defining and classifying personal and household adaptation behaviors. *Global Environmental Change* 61(102602): 1-14. https://doi.org/10.1016/j.gloenvcha.2020.102062

Introduction

Anthropogenic climate change is increasingly affecting individuals' day-to-day lives (IPCC, 2018). Climate change impacts damage homes and cause other financial losses (Grothmann & Patt, 2005), force individuals to leave their homes and communities (Adams & Adger, 2013), and raise morbidity or mortality rates, particularly for individuals who face other stressors such as poverty (IPCC, 2014; USGCRP, 2018). The resulting stress individuals experience can negatively affect their mental and physical health (Doherty & Clayton, 2011) and strain interpersonal relationships (Clayton et al., 2014, 2015). Adapting to climate change is thus not only a challenge at the international, national, regional, and local levels, but also one at the individual level (Adger et al., 2005). This challenge raises the question: What behaviors can individuals engage in to adapt to climate change impacts?

Research on this and related questions has grown rapidly in recent years. Relevant contributions make the case for why focusing on individual-level adaptation behaviors is warranted (Clayton et al., 2015; Grothmann & Patt, 2005; O'Brien & Wolf, 2010), offer specific adaptation behaviors individuals can engage in (Koerth, Vafeidis, et al., 2013; Liu et al., 2013), and study the psychosocial antecedents of adaptation behaviors (Brügger et al., 2016; Reser & Swim, 2011). A recent meta-analysis suggests that self-efficacy, outcome efficacy, negative affect, and descriptive norms have the strongest relationships with behaviors that individuals can engage in to respond to climate-related hazards (van Valkengoed & Steg, 2019a). A subsequent book chapter based on the same meta-analysis (van Valkengoed & Steg, 2019b) categorizes these behaviors into information-seeking (i.e., gaining information about risks and actions to perform), preparative actions (i.e., actions to protect one's household *before* an adverse event), protective actions (i.e., actions to protect one's household *during* an adverse event), evacuations

(i.e., temporarily or permanently leaving an area to avoid a climate related hazard), purchasing insurance (i.e., getting an insurance policy to cover climate hazard-related damages), and political actions (i.e., supporting or advocating for adaptation-related policy changes; van Valkengoed & Steg, 2019b).

Researchers have also proposed multiple theoretical models to predict these behaviors. These adaptation behavior models fall into two broad types. One is based on models such as Protection Motivation Theory (Rogers, 1975, 1983) and the Health Belief Model (Janz & Becker, 1984), which predict individuals' personal physical or mental health behaviors. These health behavior models argue that individuals' behaviors are a function of their perceived likelihood of being affected by an event and perceived ability to respond to that event. Perhaps the best-known adaptation behavior model of this type is Grothmann & Patt's (2005) process model of private proactive adaptation to climate change (MPPACC). The MPPACC is based on Protection Motivation Theory and has since been modified to add behavioral antecedents such as implementation planning (Kuruppu & Liverman, 2011), social norms (Dang et al., 2012), and place attachment (van Valkengoed & Steg, 2019b). The second type is based on models such as the Hines et al. (1987) theory of responsible environmental behavior and Stern's (2000) Value-Belief-Norm model, which identify factors that predict individuals' behaviors to protect or benefit the environment. Pro-environmental behavior models suggest that individuals' actions are a function of a complex array of predictors that include perceived responsibility to act, personal values, and different types of knowledge, among other factors. Adaptation behavior models of this type include Bradley et al.'s (2014) model of climate change psychological variables and Helm et al.'s (2018) model of psychological adaptation and pro-environmental behavior.

With this growth in scholarly research, recent major climate assessment reports have also begun to identify personal and household adaptation behaviors individuals can engage in. For example, the U.N. Intergovernmental Panel on Climate Change (IPCC) special report on the impacts of global warming above 1.5 degrees Celsius (IPCC, 2018) names behaviors to protect oneself and one's household from heat and flooding in response to climate change, as well as actions that support both adaptation and mitigation, such as adopting renewable energy and supporting climate change policies (IPCC, 2018, p. 363). The U.S. Fourth National Climate Assessment (USGCRP, 2018) adaptation chapter describes actions to protect one's home from flooding (Lempert et al., 2018). Furthermore, the United States Agency for International Development has published a guide for implementing behavior and social change programs that promote evacuations and flood protection in developing nations (Lee & Davis, 2019).

Existing scholarly research and reports have predominantly defined personal and household adaptation behaviors as actions that individuals can take to protect themselves and their households from the negative effects associated with climate change. For example, Grothmann & Patt (2005) describe *private adaptive responses* to climate change as "those that prevent damage" (Grothmann & Patt, 2005, p. 203) to one's household. Similarly, van Valkengoed & Steg (2019a) define *adaptation behavior* as "any behaviour or intention that reduces the impacts of climate-related hazards" (van Valkengoed & Steg, 2019a, p. 7). Hamilton et al. (2018) also focus on actions individuals can take. However, instead of using a negative (i.e., prevent damage or reduce negative impact) frame, they use a positive one, defining *adaptive behavior* as "a behavior that contributes to beneficial outcomes for individuals exposed to the effects of climate change" (M. Hamilton et al., 2018, p. 3).

These definitions are somewhat consistent with how the IPCC defines adaptation, i.e., "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities" (IPCC, 2014, p. 118). Namely, these definitions describe adaptation behaviors in terms of preventing harm or providing benefits. However, they do not address how actions at the personal or household level affect other individuals, communities, and the environment, including over time (Brown & Westaway, 2011; Clayton et al., 2015; Fazey et al., 2010). Thus, they do not reflect the emphasis on systems described in the IPCC's definition of adaptation "in human systems" (IPCC, 2018, p. 118).

Considering the systemic effects of personal and household adaptation behaviors is important because individual-level actions can have positive short-term benefits for those engaging in them, but these same actions can create negative effects for other people or the environment (Anderson et al., 2018; Eriksen et al., 2011). These effects ultimately determine the extent to which long-term societal adaptation can be achieved. For example, individuals may respond to increased heat with greater air conditioner use, which benefits them personally but leads to higher electricity demand (IPCC, 2014), more greenhouse gas emissions (Abel et al., 2018; IPCC, 2014), and reduced local air quality (Abel et al., 2018). Thus, focusing only on the relatively short-term, personal benefits of adaptation behaviors, at the exclusion of considering systemic effects, carries the risk of encouraging behaviors that are personally adaptive in the short term but may be personally, socially and environmentally maladaptive in the long term.

The existing theories and models of personal and household adaptation behavior can help to explain why there has been a lack of focus on the systemic effects of adaptation actions. For one, rather than being focused on longer-term outcomes, these models have centered on

individuals' behaviors as the dependent variable in response to climate change impacts, mediated by psychosocial antecedents of behavior (Figure 2-1). In the case of traditional health and pro-environmental behaviors, focusing on actions as the dependent variable may be appropriate because anticipated longer-term outcomes are relatively straightforward. For example, health behaviors provide benefits such as decreased mortality and morbidity rates, and pro-environmental behaviors may result in reduced greenhouse gas emissions. Long-term adaptation outcomes, however, are uncertain and likely to change over time (Lempert et al., 2018), so they must be examined carefully.

Moreover, existing theories focus on very different types of behaviors, contributing to the lack of clarity on adaptive actions. Protection Motivation Theory and the Health Belief Model were developed to promote behaviors that benefit one's personal health, such as exercising. Pro-environmental behavior models promote behaviors with environmental benefits, such as purchasing energy efficient lightbulbs. Existing adaptation behavior models, however, focus on promoting only one or the other, rather than both. This confusion is apparent in research on adaptation behavior. Some researchers conceptualize adaptation behaviors as having systemic impacts, such as Reser & Swim (2011) and Hamilton et al. (2018), who include feedback loops in their models. Many others, however, do not (e.g., Bichard & Kazmierczak, 2012; Liu et al., 2013). As we will argue, successful climate change adaptation behaviors should have personal, social, and environmental benefits. Thus, there is a need to clearly define what personal and household behaviors are and what specific behaviors are adaptive in this rapidly emerging research area.

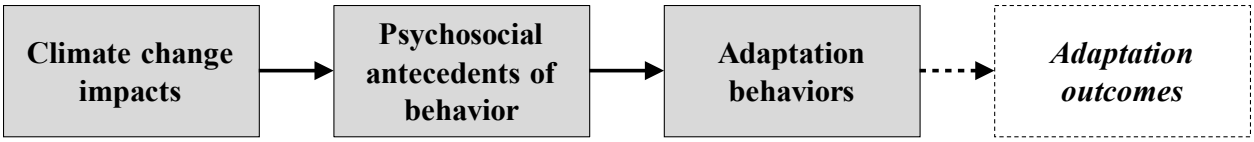


Figure 2-1. Conceptual summary illustration of current adaptation behavior models linking climate change impacts to adaptation behaviors, psychosocial antecedents. Dashed lines reflect the limited attention so far on the outcomes that adaptation behaviors are expected to achieve

The current study

To propose a more comprehensive definition of personal and household adaptation behaviors and identify specific actions consistent with this definition, we conducted a systematic, multidisciplinary review of scholarly literature on the topic. Our overarching goal was to learn (1) how researchers have defined personal and household adaptation behavior, both conceptually and in terms of the specific behaviors suggested, (2) about the climate change impacts researchers consider these actions appropriate responses to, and (3) the outcomes researchers expected these actions to contribute to. We sought to achieve these goals by answering the following research questions:

(1) To what extent are researchers' definitions of personal and household adaptation behaviors aligned with the IPCC's definition of climate change adaptation in human systems?
(2) What personal and household behaviors have scholars identified as adaptive in response to climate change impacts?
(3) What climate change impacts do scholars expect these adaptation behaviors to address?
(4) What outcomes do scholars associate with adaptation behaviors?

Note that this review focused on behaviors that individuals take on their own behalf or for their household and not on behalf of a business, government, or other organization. We refer these to as personal and household adaptation behaviors, to distinguish them from agricultural and resource management behaviors.

Methods

Our review of personal and household adaptation behavior research was based on a content analysis of 75 publications identified through a systematic, multidisciplinary literature review of scholarly publications (Figure 2-2). These publications were identified through multiple Google Scholar and Web of Science (WOS) searches using the search terms "climate change adaptation" and "human behavior" initially undertaken in October 2016, and subsequently updated in 2017, 2018, and 2019. We used these search terms rather than the specific term "adaptation behavior" so that we could capture publications that used similar but not identical phrasing (e.g., articles that described "adaptive behavior" or "adaptation measures"). The term *resilience* was not used in our search terms because *adaptation behavior* appears to have traction in this particular body of research, often used in contrast with *mitigation behavior* (e.g., Bradley et al., 2014; Helgeson et al., 2012; P. C. Stern, 1992). Furthermore, there is debate within the resilience literature on whether resilience is a trait, process, or outcome (Norris et al., 2008; Richardson, 2002). We therefore did not believe that searching for *resilience* would return as many relevant publications, although we note that one of the identified publications used the term *resilience* rather than *adaptation* behavior (Shaw et al., 2014).

Our review included a deliberately broad range of publications that focused on personal and household-level adaptation behaviors in response to climate change, apart from those addressing individual-level behaviors in agricultural, business, emergency or hazard mitigation, or resource management settings. We made this decision because reviews and syntheses of individual-level behaviors appropriate for these contexts already exist (e.g., Burton et al., 1993; Feola et al., 2015; Fischer, 2019), and because our purpose was to identify personal and household adaptation behaviors that may not already have received warranted attention. The

behaviors we focused on are analogous to what, in the energy sector, are called *residential behaviors* (Van Raaij & Verhallen, 1983); i.e., behaviors related to energy consumption in one's household. Adaptation behaviors may be relevant to energy consumption (e.g., reducing energy consumption in response to increased heat) but are also relevant to outcomes beyond household energy consumption (e.g., reducing morbidity and mortality from increased heat), so we use the more expansive term *personal and household behaviors*.

We recognize that in developing or non-industrialized nations, the distinction between personal and household behaviors, and agriculture behaviors, is not as clear as it is in industrialized nations. In developing nations, both personal and household behaviors as well as agricultural behaviors are generally conceptualized as part of overall livelihood behaviors (e.g., Feola et al., 2015). In industrialized contexts, agriculture is instead considered a type of business that only some individuals participate in (The World Bank, 2007). All individuals can engage in personal and household adaptation behaviors, so we included research from developing nations if the publication's authors named personal and household behaviors e.g., selecting the location of one's home (Anggraeni et al., 2014), that did not directly include agricultural decision-making. Instead, personal and household behaviors may overlap with agricultural and livelihood settings but do not exclusively apply to them. For example, while selecting where to live can have livelihood implications, the decision to move is nonetheless a household decision and thus classified as a personal and household behavior.

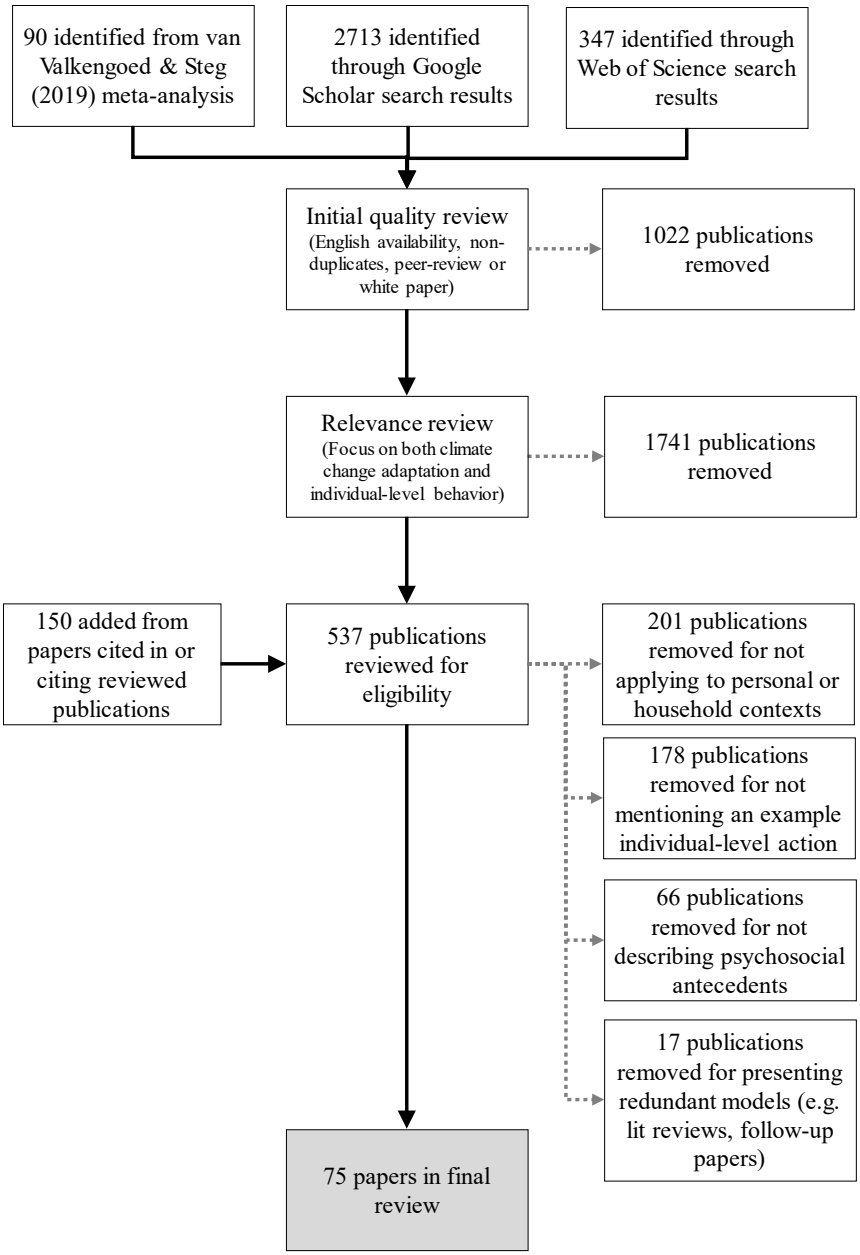


Figure 2-2. Summary of systematic literature review process

Peer-reviewed publications and commissioned scholarly white papers, such as the American Psychological Association's report on the psychological impacts of climate change (Swim et al., 2009), were considered. The same was the case for theoretical or synthesis publications as well as quantitative or qualitative empirical research. The initial review identified 2,713 publications through Google Scholar and 347 through Web of Science. The 90

publications included in van Valkengoed & Steg's (2019a) meta-analysis of the psychological antecedents of adaptation behaviors were added for consideration in early 2019.

We began with an initial assessment of the identified publications to eliminate duplicates, ensuring that they were peer-reviewed articles or white papers, and available in English. Next, we examined them to ensure they addressed individual-level human behaviors in the context of climate change adaptation. At this stage, publications that addressed relevant topics (e.g., emergency response, urban resilience) but did not explicitly link their work to climate change were removed. We made this decision to ensure that we captured how scholars conceptualized adaptation behaviors as distinct from, for example, hazard mitigation, climate change mitigation, and pro-environmental behaviors. Publications that described non-human adaptation behaviors were eliminated as well. Upon reading the remaining publications, we found that many of them cited additional papers, or were cited by subsequent publications, that appeared relevant but had not been identified through the Google Scholar or WOS searches (e.g., articles that cited Grothmann & Patt, 2005), or the meta-analysis by van Valkengoed & Steg (2019a). These citations resulted in 150 additional potentially relevant publications, yielding a total of 537 publications that we reviewed for inclusion in our final sample.

To determine eligibility for this sample, three inclusion criteria were used. First, publications had to describe personal or household behaviors, not ones taken on behalf of an organization, or to support agriculture, livelihood, and resource management goals. Second, the publication had to name at least one specific behavior (e.g., supporting changes in floodplain regulation, or purchasing flood insurance). Third, the publication had to name at least one psychological or social antecedent of these behaviors (e.g., personal values or perceived threat of climate change impacts). We included the latter criterion to compare this study's findings with

the adaptation behavior models described earlier (e.g., Grothmann & Patt, 2005; Reser & Swim, 2011; van Valkengoed & Steg, 2019a, 2019b). Because we discovered that several publications presented duplicate models or redundant data that had been published elsewhere (i.e., in the case of reviews or book chapters), we eliminated 17 additional publications, retaining those that had more detailed theoretical models and lists of behaviors, or, if content was very similar, we selected the most recent publication. As such, our selection criteria differed from those by Van Valkengoed & Steg's (2019a) meta-analysis. Due to the nature of their study, Van Valkengoed & Steg (2019a), synthesized results across quantitative studies, meaning that they excluded theoretical and qualitative research. Second, because they sought to identify antecedents of adaptation behaviors, they used a pre-determined list of climate change hazards, such as flooding, wildfires, or heat, but did not require that the reviewed studies mention climate change. As a result, our respective final samples were very different, with only 14 overlapping publications as of the end of 2018.

The content of the publications included in our study was analyzed by coding the definitions of personal and household adaptation behavior, climate change impacts, specific sample adaptation behaviors, and outcomes these behaviors were expected to contribute to. To develop these codes, an Excel file was created that included relevant direct quotes from each publication. The lead author then proposed codes for definitions, behaviors, impacts, and outcomes based on themes identified in an initial content analysis of 37 publications identified in the first round of the search. The co-author reviewed the proposed codes and both authors agreed on a final codebook. Two additional researchers reviewed a sub-set of 12 papers to determine their agreement with the coding used. Once the final codes were determined, the lead author applied these codes to the remaining publications. The lead author developed binary indicator

variables for each code (1 or 0) to create frequency counts. For example, if a publication mentioned using psychological coping as an adaptation behavior but mentioned no other behaviors, the variable "coping" was marked as a 1 and all other behaviors were marked as 0. We also coded for the country where research was conducted (as named in the publications), and the disciplinary backgrounds of the lead authors based on the name of the terminal degree listed in their curriculum vitae, or department if their CV could not be found. Frequencies and cross-tabulations were subsequently calculated using Stata v.15.

Comparing our methods to those in Van Valkengoed & Steg's (2019a) meta-analysis

While there are some similarities between our respective research questions in our studies, our methods differed in important ways. For one, our search criteria were not the same. Van Valkengoed & Steg (2019a) searched for publications that described responding to hazards such as wildfire, flooding, or extreme events and included publications that mentioned these specific hazards even if the hazards were not clearly linked to climate change in the publication text. In contrast, we used the much broader search term of "climate change adaptation." This meant that every publication we included was framed specifically around climate change adaptation, while the publications that Van Valkengoed & Steg (2019a) included were often applicable to climate change impacts but did not necessarily discuss climate change, or climate change adaptation, explicitly. For example, 40 publications included in their meta-analysis never used the term "climate change adaptation" or "resilience" at all. Instead, these publications described natural hazards that are impacted by climate change, such as flooding, but did not link those hazards to climate change. Some publications from the meta-analysis, moreover, did not even describe a climate change-driven hazard: For example, two papers included in their review analyzed behaviors that were relevant to responding to tornadoes (Mulilis et al., 2000; Senkbeil

et al., 2014), a hazard which is not clearly linked to climate change (National Academies of Sciences, Engineering, and Medicine, 2016). Van Valkengoed & Steg's (2019a) selection criteria were appropriate given the goals of their meta-analysis, i.e., identifying ways to protect people from climate hazards, but they were not appropriate for our study, which sought to increase clarity about how adaptation behaviors are defined within the context of climate change research specifically. This difference in inclusion criteria resulted in 62 of van Valkengoed & Steg's (2019a) sample publications being excluded from our analysis.

Second, we included an explicit criterion that the publication had to describe personal and household behaviors rather than agricultural, resource management, livelihood, or business behaviors, while Van Valkengoed & Steg (2019a) did not. This criterion excluded 11 of their sample publications from our analysis.

Third, we found that three of their publications duplicated data already published in other publications we had already included in our review, so we excluded those publications.

Fourth, because our review was not a meta-analysis, we allowed publications that did not include quantitative measurements of relationships between psychosocial antecedents (i.e., motivators) and behaviors. As a result, we were able to include review and theory publications, qualitative research, and mixed methods research publications that their meta-analysis could not capture, and which accounted for 35 of the publications that we included in our review.

Results

Summary descriptive statistics

Although the earliest publication describing adaptation behavior included in our review was published in 1992 (Stern, 1992), the majority were published in or after 2013 (n=48, 64%). The publications' lead authors had a broad range of disciplinary backgrounds. Based on their CVs,

they had terminal degrees in geography (*n*=19, 25%), psychology (*n*=18, 24%), economics (*n*=7, 9%), public health (*n*=4, 6%), urban planning (*n*=3, 4%), and other fields (n=24, 32%). Most articles consisted of empirical studies that used quantitative (*n*=40, 53%), qualitative (*n*=7, 9%), or mixed methods (*n*=7, 9%). The remaining publications were theoretical or syntheses of existing studies (*n*=21, 28%). Most empirical publications were based on work conducted in Europe (*n*=25, 33%), followed by Australia and the Pacific Islands (*n*=16, 21%), Asia (*n*=7, 9%), North America (*n*=8, 11%), and Africa (*n*=2, 3%).

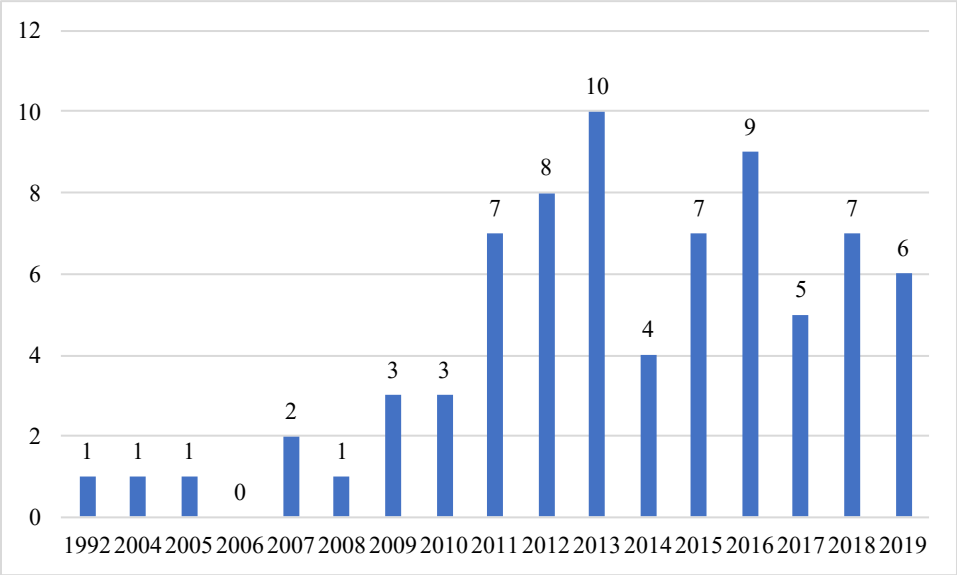


Figure 2-3. Year of publication for all included publications (N=75)

Table 2-1. Summary of study locations for all publications (N=75)

Location of study	**n**
Algeria	1
Australia	14
Cambodia	1
Canada	2
China	2
Denmark	1
Germany	7
Greece	1
India	1
Indonesia	2
Ireland	1
Italy	1
Malaysia	1
Mexico	1
Netherlands	3
Norway	1
Philippines	1
Portugal	1
Small Island Nations (Kiribati; Samoa; Tuvalu; Tonga)	2
Spain	2
Sweden	1
Switzerland	1
Taiwan	1
UK	11
USA	5
Zimbabwe	1
None/Not applicable	20

To what extent are researchers' definitions of personal and household adaptation behaviors aligned with the IPCC's definition of climate change adaptation in human systems?

Because of the prominent influence of the IPCC definition on current definitions of adaptation behavior, we used the two major components of this definition, "avoiding harm" and "exploiting beneficial opportunities," to analyze how adaptation behavior was defined in the reviewed publications. Most publications defined individual-level adaptation behavior as actions that reduce harms (n=59, 79%), just a few in terms of potential benefits (n=4, 5%), and some in terms of both (n=9, 12%).

We also analyzed the extent to which definitions of adaptation behaviors accounted for the

systemic effects of adaptive actions. For this analysis, we coded for who or what these definitions suggested could be affected by adaptation behavior; i.e., individuals, other people, or the environment. Most authors defined adaptation behaviors only in terms of benefitting individuals (*n*=40, 53%), although number also addressed co-benefits to other people (*n*=12, 16%), the environment (*n*=8, 11%), or all three groups (*n*=7, 9%). Some authors defined adaptation behaviors as only affecting other people (*n*=3, 4%) or other people and the environment (*n*=1, 1%). A few authors did not identify any specific beneficiaries of adaptation actions (*n*=4, 5%).

What personal and household behaviors have scholars identified as adaptive in response to climate change impacts?

The authors of the reviewed publications identified more than 100 potential personal and household adaptation behaviors. We classified these behaviors into eight types: civic engagement, consumption, coping, household protection, learning, lifestyle change in place, migration, and self-protection. Table 2-2 provides an overview of each type, including a description and select examples. The complete list of identified behaviors, as well as references to the publications that mentioned them, are included in the supplementary materials.

Table 2-2. Classification, description, and examples of personal and household climate change adaptation behaviors

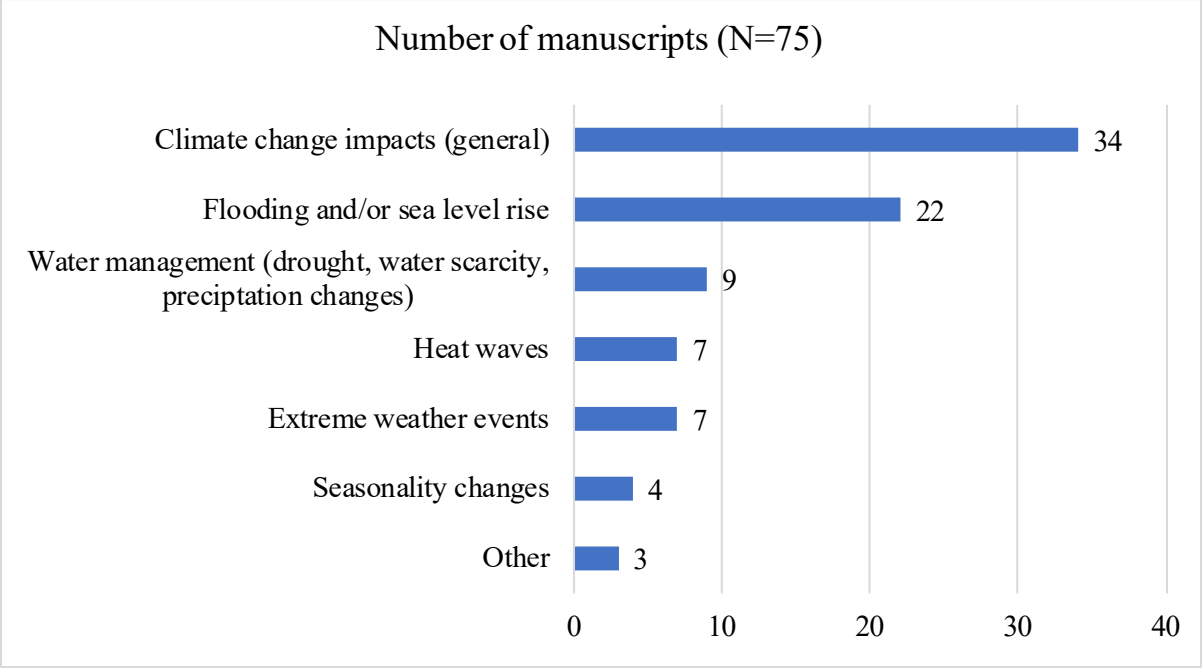
Classification of adaptation behavior	**Description**	**Example**
Civic engagement (*n*=31, 41%)	Acting alone or with other people to support or advance climate change adaptation policies, social and environmental change, or other community adaptation goals	• Joining/volunteering with a community organization • Policy advocacy • Policy support
Consumption (*n*=17, 23%)	Actions to benefit the environment and/or conserve natural resources, based around product purchase and use decisions	• Reducing energy consumption • Green product purchases • Using public transit instead of driving • Water conservation
Psychological coping (*n*=18, 24%)	Mental management of stress associated with the impacts of climate change	• Seeking support from or with others • Using coping strategies such as mental reframing or adjusting expectations
Household protection (*n*=35, 47%)	Physical actions to proactively protect one's family members, house, and/or possessions from specific climate change impacts	• Household-level purchases (insurance, insulation, sandbags) • Moving equipment to upper floors • Emergency preparedness kits
Learning (*n*=18, 24%)	Building new understanding about adapting to climate change	• Information seeking or sharing • Changes in knowledge • Social learning
Lifestyle change in place (*n*=8, 11%)	Making long-term changes to one's way of living	• Growing one's own food • Changes to overall patterns of behavior (e.g., voluntary simplicity)
Migration (*n*=17, 23%)	Permanently leaving one's original home in response to climate change impacts	• Changing housing type or location (within the same city or region) • Moving to a new city or region
Self-protection (*n*=26, 35%)	Personal physical actions, planned or unplanned, to protect oneself from specific climate change impacts	• Drinking water, wearing light clothes during a heat wave • Evacuations during flooding

Other (*n*=11, 15%)	• Persuading others to migrate • Cleanup after a disaster/personal disaster recovery • Donations or financial support for migration or adaptation initiatives • Travel plan changes (i.e., choosing a new travel destination or time) • Prayer • Changing gardening practices

Most authors mentioned more than one type of adaptation behavior in their publication (*n*=46, 61%), but no single type of adaptation behavior was mentioned in all publications nor in the majority of publications.

What climate change impacts do scholars expect these adaptation behaviors to address?

Nearly half of the reviewed publications did not identify specific climate change impacts that individual-level adaptation behaviors were expected to address, but instead referred to climate change impacts in general (*n*=34, 45%; Figure 2-4). When publications focused on specific impacts, they tended to mention flooding or sea level rise. Furthermore, when applying adaptation behaviors to impacts, most of the adaptation behaviors identified were suggested in response to climate change impacts in general (Table 2-3). Household protection behaviors were most frequently recommended in the context of flooding and sea level rise. Migration was recommended in response to sea level rise as frequently as to climate change in general.



* "Other" impacts included vector-borne diseases (n=1), wildfires (n=1), and coral reef bleaching (n=1).

Figure 2-4. Number of reviewed publications identifying climate change impacts (N=75)

Table 2-3. Cross-tabulation of adaptation behaviors identified as appropriate responses to climate change impacts

	Civic engage-ment (*n*=31)	Consump-tion (*n*=17)	Coping (*n*=18)	Household Protection (*n*=35)	Learning (*n*=18)	Lifestyle change in place (*n*=8)	Migration (*n*=17)	Self-Protection (*n*=26)	Other (*n*=11)
Climate change (general) (*n*=34)	18	13	13	13	10	7	7	10	5
Increased flooding and/or sea level rise (*n*=22)	8	1	2	16	6	0	8	5	1
Water management (*n*=9)	4	1	1	2	1	0	1	0	1
Heat waves (*n*=7)	1	1	0	2	1	0	1	7	0
Extreme events (*n*=7)	3	1	3	4	2	0	3	4	2
Seasonality changes (*n*=4)	1	1	1	1	0	1	1	2	3
Other (*n*=3)	0	0	0	1	1	0	0	1	1

Note: The *n* for each column and row indicates the total number of publications in each category, e.g., 31 publications described civic engagement behaviors, and 34 publications described general climate change impacts. The *n* for each table cell indicates the number of publications in both categories, e.g., 18 publications described both civic engagement behaviors and general climate change impacts. Publications may describe multiple behaviors and multiple impacts. Darker colors designate cells with a larger *n* (lightest to darkest green, *n* = 1-5, 6-10, 11-15, 15-20).

What outcomes do scholars associate with adaptation behaviors?

The reviewed publications described several outcomes that scholars expected as a result of engagement in personal and household adaptation behaviors (Table 2-4). These included household protection and safety outcomes, such as limiting flooding damage to individuals' homes (Grothmann & Patt, 2005; Koerth, Vafeidis, et al., 2013) and financial outcomes, such as savings for individuals, insurers, and government agencies (Adams & Adger, 2013; P. C. Stern, 1992). They also included mental health outcomes and improvements to overall well-being, particularly from reductions in stress; physical health outcomes such as reduced likelihood of heat strokes or injuries from disasters; and social outcomes including improvements to social cohesion through increased communication with neighbors and reduced interpersonal conflict (Amundsen, 2015; Doherty & Clayton, 2011). Several publications also anticipated environmental quality outcomes, such as reduced greenhouse gas emissions (Unsworth et al., 2013). Although these latter benefits are typically associated with climate change mitigation, we mention them here because the authors of the reviewed publications identified them as outcomes of adaptation behavior.

Table 2-4. Outcomes individual-level adaptation behaviors are expected to contribute to

	Identified outcome	**Distinguished between behavior and outcome; did not assume one will lead to other**	**Measured behavior and outcomes**
	n	**n**	**n**
*Total publications**	*56*	*18*	*4*
Safety and protection outcomes	20	0	0
Community outcomes	17	11	3
Environmental outcomes	12	6	2
Mental health outcomes	11	7	1
Physical health outcomes	9	3	2
Financial outcomes	5	2	0
Other outcomes**	9	4	1

* Note that frequencies for each individual outcome will add up to more than the total publications because most publications mentioned multiple outcomes.

** "Other" outcomes included personal thermal comfort (*n*=1), holistic quality of life (*n*=1), personal growth (*n*=1), general self-protection (*n*=2), decreased overall flooding risk (*n*=1), general change in climate change impacts (*n*=1), adapting local land (*n*=1), and maintaining water supply (*n*=1)

It is important to note that most authors did not explicitly distinguish outcomes from behaviors. Instead, many appeared to assume that desired outcomes will occur as a result of adaptation behaviors (*n*=38, 51%), or did not mention outcomes at all (*n*=19, 25%). For example, Koerth et al.'s (2013) study of homeowner adaptation behaviors in coastal communities was coded as a publication whose authors assumed adaptation outcomes from behaviors because it described adaptation behaviors as "measures which ensure safety in the case of flooding and protecting property in the long term" (Koerth, Vafeidis, et al., 2013, p. 901). These authors measured the number of respondents who carried out behaviors such as planning for floods and preparing emergency kits but did not verify to what extent these behaviors ultimately resulted in increased safety or property protection outcomes. In contrast, the authors of 18 publications (24%) conceptualized adaptation behaviors as distinct from adaptation outcomes. For example, Doherty & Clayton (2011) and Reser & Swim (2011) present theoretical models that describe the

mental health and social impacts of climate change, such as stress, grief, social upheaval, and interpersonal conflict. These models point out that human behavior influences, and is in turn influenced by, these factors. These authors recognize mental health and social outcomes as distinct from behaviors such as coping and migration, and classified them as such. Only four of the reviewed publications (5%), measured both adaptation behaviors and resulting outcomes (Amundsen, 2015; Daoudi et al., 2019; Helm et al., 2018; Liu et al., 2013). For example, Liu et al. (2013) measured both the behaviors individuals reported engaging in during a heat event, such as drinking water, as well as the extent to which individuals experienced heat stroke symptoms during that same event (i.e., physical health outcomes).

Discussion

By synthesizing theoretical, quantitative, and qualitative research on individual-level adaptation behaviors from multiple disciplines, this review contributes to strengthening our collective understanding of what personal and household adaptation behaviors are. To advance this understanding, we analyzed researchers' definitions of personal and household adaptation behaviors; actions they identified as adaptive; climate change impacts they believed these actions to be appropriate responses to; and outcomes they expected these actions contribute to. It is our hope that this study will advance further adaptation research and assist those seeking to empower individuals, who may otherwise not know what to do about climate change impacts in their lives, to take action to protect and benefit themselves, their communities, and the environment.

What personal and household adaptation behaviors can individuals engage in?

Consistent with other recently published work (van Valkengoed & Steg, 2019a, 2019b), this review resulted in the identification of many behaviors, which could be classified into a more limited number of categories. More specifically, our review identified over 200 possible actions

that we combined into eight categories, whereas Van Valkengoed & Steg's (2019a, 2019b) meta-analysis was based on six categories derived from 75 specific actions. The fact that our study's findings broadly converge with these authors' (Table 2-5) supports the validity of our respective studies. This observation is noteworthy because of the different nature (i.e., quantitative meta-analysis vs. content analysis of theoretical, quantitative, and qualitative studies) and relatively distinct samples (i.e., only 14 overlapping publications) of the two independently conducted studies. Thus, although scholarship on adaptation behavior is relatively new, it appears that there are several areas of agreement regarding what personal and household behaviors may be adaptive.

Our study also provides several advances beyond those by Van Valkengoed & Steg (2019a, 2019b). Because we conducted a literature review rather than a quantitative meta-analysis, we could include more publications and thus, more behaviors than Van Valkengoed & Steg (2019a). Table 2-5 illustrates how our adaptation behavior categories differ from those they identified. For one, our categories include more example actions. For example, whereas Van Valkengoed & Steg (2019b) proposed *political action* as a category, we include political actions as one part of *civic engagement.* Civic engagement not only includes political actions such as advocating for adaptation policies but also relevant non-political adaptation actions such as planning a community project (e.g., Amundsen, 2015), knowing one's neighbors (e.g., Koerth, Vafeidis, et al., 2013; Süsser, 2018), or joining a community organization (e.g., Süsser, 2018). Our other remaining categories similar encompass those by Van Valkengoed & Steg (2019b), i.e., learning with information-seeking; household protection with purchasing insurance and preparative actions; self-protection with short term evacuation and protective actions; and migration with long-term evacuation.

Moreover, we suggest three additional types of adaptation behaviors, not addressed by Van Valkengoed & Steg (2019b). The first are coping behaviors. Although Van Valkengoed & Steg (2019b) describe the need for "mental preparedness or psychological adaptation to climate change" (van Valkengoed & Steg, 2019b, p. 51), they did not include coping as an adaptation behavior. We incorporated it because psychologists consider it an adaptation behavior (Homburg et al., 2007; Reser & Swim, 2011), and because we believe it would otherwise be overlooked. The other two types of behaviors are consumption behavior and lifestyle changes (e.g., Capstick et al., 2014; Gilg et al., 2005). We distinguished them from one another because consumption behaviors are shorter term than lifestyle changes. These actions are often classified as pro-environmental behaviors, but we found that several publications mentioned these actions while referring to them as adaptation behaviors (e.g., Unsworth et al., 2013). Although neither of these types of behavior respond to specific climate change hazards, we argue that they should nonetheless be recognized as adaptive because of their implications for long-term climate change adaptation.

Table 2-5. Comparison of the types of adaptation behaviors identified by our literature review versus by Van Valkengoed & Steg's (2019b) meta-analysis

Types of behavior (This Review)	**Description (from Table 2-2)**	**Type of behavior (Van Valkengoed & Steg, 2019b)**	**Description (from Table 1, p. 5-6 unless otherwise noted)**	**Example actions (from Table 1, p 5-6)**	**Additional sample actions included in our review's type**
Learning	Building new understanding or gaining new information about adapting to climate change	Information seeking	"Expending time and effort to gain more information about specific climate-related hazards, to identify whether you are at risk of a hazard, and gaining information on which actions to perform to successfully adapt to climate change"	"Studying weather forecasts, using flood maps, looking up information on how to flood-proof the house, reading government brochures on preparedness, listening to the radio during a climate-related hazard"	• Changes in knowledge and mental models • Social learning
Household protection	Physical actions to proactively protect one's family members, house, and/or possessions from specific climate change related events	Preparative actions	"Structural actions taken before the onset of a climate-related hazard aimed at reducing the probability of being affected by a hazard or minimising its negative impact"	"Boarding up windows before a hurricane, installing valves with back-flow prevention, cleaning gutters, storing non-perishable foods"	• Emergency preparedness kits • Purchasing insurance
Self-protection	Personal physical actions, planned or unplanned, to protect oneself from specific climate change related events	Protective actions	"Actions taken during an ongoing climate-related hazard to avoid or reduce its impact"	"Defending the home against wildfire, not driving through floodwater with a vehicle, staying inside during a hurricane, staying cool during a heatwave"	• Evacuation

Types of behavior (This Review)	**Description (from Table 2-2)**	**Type of behavior (Van Valkengoed & Steg, 2019b)**	**Description (from Table 1, p. 5-6 unless otherwise noted)**	**Example actions (from Table 1, p 5-6)**	**Additional sample actions included in our review's type**
Self-protection (short-term); Migration (long-term)	Self-protection (see above); Migration: Permanently leaving one's original home in response to climate change	Evacuation	"Temporarily moving away from an area to avoid the negative impacts of climate-related hazard; may also include leaving an area permanently if required"	"Complying with government-issued evacuation, planned retreat, migration"	N/A
Household protection	See above	Purchasing insurance	"Purchasing an insurance policy that covers losses from one or multiple climate-related hazards"	"Flood insurance, wildfire insurance, homeowner insurance"	N/A
Civic engagement	Acting alone or with other people to support or advance climate change adaptation policies, social and environmental change, or other community adaptation goals	Political action	"Influencing local or national governments to implement adaptation policies"	"Voting in favour of adaptive policies, protesting, participating in town hall meetings, forming an action group, signing a petition"	• Getting to know neighbors • Joining a community organization • Planning a community event
New categories added as a result of our review					
Psychological coping	Mental management of stress associated with the impacts of climate change	Mental preparedness or psychological adaptation*	"the way in which people cope with the anxiety and stress caused by the prospect of climate change and climate-related hazards" (p. 51)	N/A	• Seeking support from or with others • Reframing strategies

Types of behavior (This Review)	**Description (from Table 2-2)**	**Type of behavior (Van Valkengoed & Steg, 2019b)**	**Description (from Table 1, p. 5-6 unless otherwise noted)**	**Example actions (from Table 1, p 5-6)**	**Additional sample actions included in our review's type**
Consumption	Actions to benefit the environment and/or conserve natural resources, generally based around product purchase and use decisions	N/A	N/A	N/A	• Reducing energy consumption • Green product purchases • Using public transit instead of driving • Water conservation
Lifestyle	Making long-term changes to one's way of living	N/A	N/A	N/A	• Growing one's own food • Changes to overall patterns of behavior (e.g., voluntary simplicity)

Although our proposed typology of adaptation behaviors is more comprehensive than any offered to date, we also acknowledge that it can benefit from further improvements. For one, several identified behaviors did not fit any of the proposed types (e.g., recovery and cleanup after and extreme event; Stewart, 2009) but were not mentioned often enough to justify the creation of another category. Other actions were ambiguous as to which category was the best fit. For example, prayer (Beyerl et al., 2018) may be a form of psychological coping, self-protective action, or maladaptation (i.e., inaction), depending on one's interpretation. As this field continues to develop, we anticipate that this list of behaviors will grow.

How should personal and household adaptation behavior be defined?

The many behaviors identified as a result of this review also provide a solid basis for a more comprehensive definition of personal and household adaptation behavior. There are several criteria for what this definition should include. For one, we argue that such a definition should identify the *purpose* of adaptation described in the IPCC's definition, i.e., preventing harm and exploiting beneficial opportunities (IPCC, 2014). Most of the definitions and sample adaptation behaviors offered focused on the former rather than the latter. This is not surprising because climate change impacts are expected to be largely negative (IPCC, 2014, 2018), and researchers may be aware that individuals are biased in favor of preventing harm rather than obtaining potential benefits when future outcomes are uncertain (Tversky & Kahneman, 1992). Nonetheless, we believe that a definition of personal and household behavior should also be framed in terms of beneficial opportunities, not only because this is a component of adaptation (IPCC, 2014) but also because hope plays important role in motivating individuals to act on climate change (Ojala, 2012, 2015). As such, we recommend that the definition of adaptation behavior account for both potential purposes (i.e., *protection* from harm and gaining *benefits*).

Furthermore, a definition of adaptation behavior should explicitly identify *who or what is affected* by the outcomes of these actions. Our analysis of current definitions of adaptation behavior, sample behaviors, and expected outcomes showed that most researchers conceptualize adaptation behavior as only affecting the individuals who engage in that behavior (i.e., the individuals *themselves*). For example, some publications defined adaptation behaviors as only creating financial savings for a homeowner (Botzen et al., 2009, 2013) or protecting one's personal health (Liu et al., 2013). Other adaptation researchers, however, also consider how personal and household adaptation behaviors affect *other people* or the *environment*. These authors conceptualize adaptation behavior as having personal, social, and environmental co-benefits, include civic engagement and consumption behaviors, and accordingly expect social and environmental outcomes (e.g., Brügger et al., 2015; Hagen et al., 2016; Helm et al., 2018). Other authors specifically describe concerns about behaviors that are adaptive at the individual level but may be socially and environmentally maladaptive. One study, for example, discovered that some individuals spend more time in their cars in response to hotter summers, resulting in reduced air quality and increased GHG emissions (Palutikof et al., 2004). Other studies found that individuals who cope with climate change by ignoring or minimizing its impacts, experience lower personal stress but do not engage in consumption or civic engagement actions (Homburg et al., 2007; Ojala, 2012). These kinds of actions put long-term adaptation goals at risk. We therefore argue that a definition of personal and household adaptation behaviors should consider to what extent these actions affect not only individuals but also other people and the environment.

The personal and household adaptation behaviors identified in the reviewed publications varied on several additional dimensions as well. For one, they differed in whether the *actor*

engaged in adaptation behaviors *alone,* with others in their *household*, or in collaboration with *community* members. Many authors conceptualized adaptation behaviors as actions that were taken alone (e.g., Hine et al., 2016; Liu et al., 2013). Some, however, recognized that there are adaptation behaviors that require working with others, either within one's household or with others in one's community. Actions with one's community, for example, are particularly relevant for civic engagement. Individuals can also engage in learning (Koerth, Vafeidis, et al., 2013; Koerth, Jones, et al., 2013) and coping (Swim et al., 2009) alongside other people. Therefore, the actor should also be included in a definition of personal and household adaptation behavior.

Furthermore, the authors of the reviewed publications focused on different *time scales*: *short*-term, *long*-term, or both. For example, self-protection actions consisted mostly of short-term behavioral responses such as drinking more water or staying in the shade during heat waves (Akompab et al., 2013; Liu et al., 2013), or evacuating during floods (Lo, 2013). In contrast, lifestyle changes such as changing consumption patterns and habits (Daniels, 2010; Osberghaus et al., 2010) as well as migration (Adams & Adger, 2013; J. Song & Peng, 2017) focus on the longer term. Yet other behaviors address both time scales. Civic engagement, for example, included short-term actions such as support for discrete adaptation policy changes (García de Jalón et al., 2013; Lam, 2015) and longer-term reforms such as changing building codes (Brügger et al., 2016) and policies to improve drinking water quality (Thaker et al., 2016). As such, the literature on adaptation behaviors is consistent with broader literature on adaptation, which has defined as both a short- and long-term phenomenon, and one either focused on preserving or changing the socioecological status quo (e.g., Fazey et al., 2010; Milly et al., 2008; Pelling, 2011). Therefore, the definition of adaptation behavior should explicitly consider time scale.

Lastly, the adaptation behaviors researchers identified varied in the *timing* of actions*,* i.e., the extent to which they are *proactively* taken before or *reactively* taken during or after a particular event associated with climate change (Fischer, 2019; Stewart, 2009). Household protection actions, such as elevating one's home to prevent flooding damage (Koerth, Vafeidis, et al., 2013; Koerth, Jones, et al., 2013), are clearly proactive, whereas self-protection actions such as evacuating during a flood or extreme event are reactive (Sattler, 2017; P. C. Stern, 1992). Coping could be both reactive in response to a specific event (Homburg et al., 2007) and proactive when individuals develop coping strategies ahead of such events (Clayton et al., 2014). Similar pro- and reactive examples can be made for each of the other personal and household adaptation behaviors, so this dimension should be considered in the definition as well.

In summary and based on the above, we propose that personal and household adaptation behaviors be defined as *reactive or proactive actions that individuals can take, alone or with others, to respond to the impacts of climate change, and to protect or benefit themselves, others, and/or the environment in the short and long term.* This more comprehensive definition advances our understanding of what adaptation behaviors are by including all of the dimensions that arose from our review. Note that this definition captures both the individual and more systemic aspects of personal and household adaptation behavior. As such, it is consistent with work by researchers who have argued that climate change adaptation should not only focus on personal protection but also account for the long-term effects of actions on others (Eriksen et al., 2011; Lempert et al., 2018).

Figure 2-5 classifies the different types of adaptation behaviors based on the above definitional elements. For example, self-protection behaviors are protection-oriented, reactive behaviors taken alone in the short-term that affect only oneself, while civic engagement actions

might be benefit- or protection-oriented, proactive or reactive behaviors taken with others in the community in the short or long term that affect oneself, one's community, or the environment. Coping and learning behaviors, because they are internal within individuals, are the only behaviors that can potentially address every element. However, they require no overt action and thus, primarily serve to enable other, more physical actions. Thus, no single type of behavior can address all adaptation needs; rather, a wide range of behaviors are necessary.

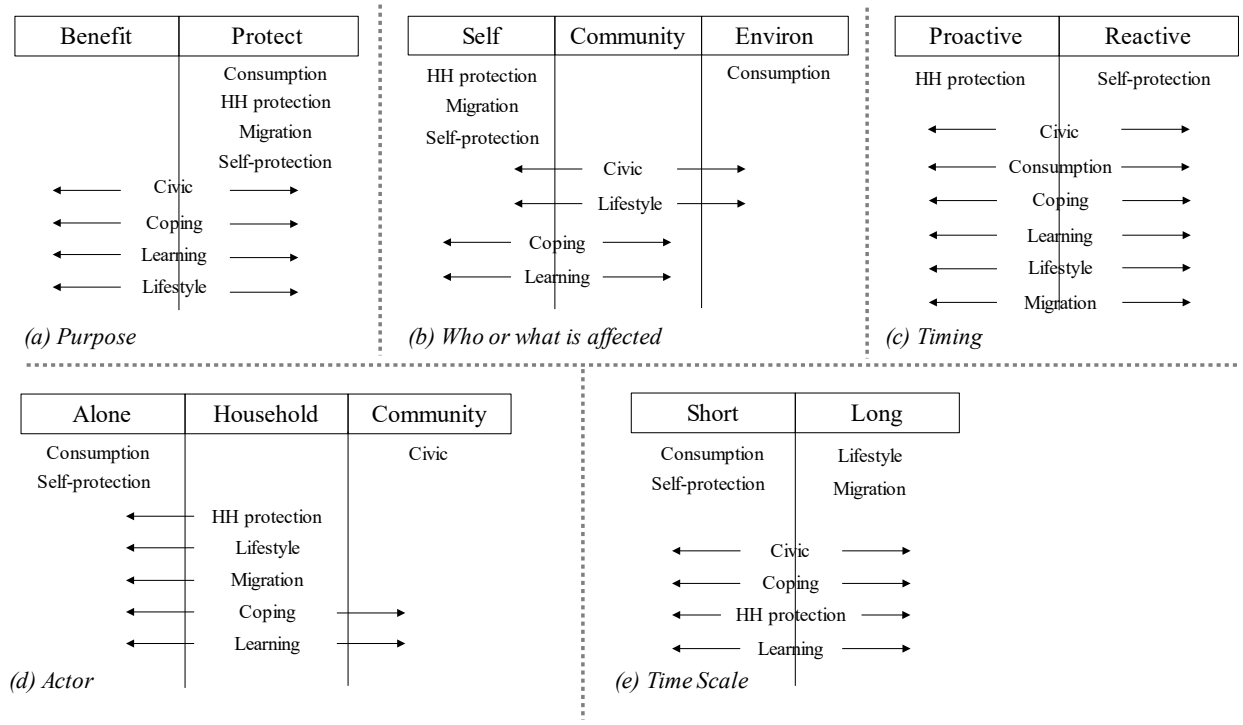


Figure 2-5. Conceptual alignment of different types of personal and household adaptation behavior to different components of the definition of personal and household adaptation behavior: (a) Purpose, (b) Who or what is affected, (c) Timing, (d) Actor, and (e) Time scale.

Future directions

We offer several recommendations for future researchers of personal and household adaptation behavior. First, we recommend that individual-level adaptation behavior research, as well as policy and planning efforts, consider how personal and household adaptation behavior can better support longer term adaptation, including sustainability goals (e.g., Eriksen et al., 2011; United Nations, 2015). Our review's results suggest that personal lifestyle changes, and the effects of

adaptation behaviors on other people and the environment, have not received much attention in adaptation behavior research. Long-term adaptation goals, however, will not be achievable without a focus on sustainability (Eriksen et al., 2011). One way this shift in focus can occur is through adding an outcome orientation to adaptation behavior research and practice. Select studies, such as Wamsler and Brink's (2014) analysis of the goals of various adaptive measures account for outcomes, but our results suggest that few others do. There is no question that adaptation behavior must address immediate climate change impacts at hand. However, exclusive attention to impacts, without consideration of long-term goals, can result in short-term behaviors that undermine long-term outcomes. For example, individuals are more likely purchase flood insurance after floods but may not consider whether it might be safer for them to move out of a floodplain altogether (Anderson et al., 2018). Moreover, focusing on outcomes is consistent with the principles of sustainable adaptation – which calls for consideration of feedbacks between local and global processes (Eriksen et al., 2011) – and is also consistent with recommendations from other bodies of literature such as backward design (Wiggins & McTighe, 2005) and program evaluation (Chen, 1990; Patton, 2008).

In addition, we encourage researchers to explore the potential positive or negative spillover effects (Nash et al., 2017) among these different types of adaptation behaviors. No single adaptation behavior will be sufficient for individuals and households to adapt. Instead, engaging and sustaining a range of adaptation behaviors will be necessary. Spillover research examines how one type of behavior might result in the uptake of other types of related behaviors (Truelove et al., 2014). To date, researchers have focused on the adoption of discrete adaptation behaviors rather than exploring the relationships among different actions, such as whether a person who participates in a civic engagement action subsequently engages in a household

protection action (or vice versa). In addition to research on outcomes, understanding spillover can help to inform policies and programs to foster adaptation actions.

Furthermore, the question of *who* is engaging in adaptation behaviors is also one that deserves greater consideration than it has received so far (Eriksen et al., 2011). Different individuals have different adaptation behavioral options, and some of those options may immediately benefit an individual actor but place others, the environment, and their own future well-being at greater risk of harm (Eriksen et al., 2011; Moser & Ekstrom, 2010). For example, some may invest in flood protections that meet current flooding levels but not future extremes. As a result, these individuals may develop a false sense of security (Fazey et al., 2010; Logan et al., 2018) or place neighbors at greater flooding risk (Balaji et al., 2017). Moreover, there are important differences in populations within communities and across the globe. Namely, wealthy individuals have many more behavioral options than individuals in poverty (Swim et al., 2011), even though people in poverty are most likely to feel the earliest and strongest negative impacts of climate change (IPCC, 2014). These inequalities can be exacerbated by individuals' adaptation behaviors when they focus only on protecting themselves (Eriksen et al., 2011). For example, wealthy individuals can invest in household protection or buy a new house altogether (i.e., migrate) relatively easily. However, when wealthy individuals move away from coastlines, they may increase housing costs in inland communities (Adams & Adger, 2013). Future research on adaptation behaviors must therefore consider differences in population segments and contexts.

Finally, we offer one caveat regarding the inclusion of consumption behaviors in future research on personal and household adaptation behavior. In several publications we reviewed, consumption behaviors were explicitly called adaptation behaviors (e.g., Reser et al., 2012; Unsworth et al., 2013), but the named behaviors did not clearly differ from conventional pro-

environmental behaviors. In fact, one publication, which we excluded from the full review because it did not describe specific adaptation behaviors, defined adaptation behavior as a type of pro-environmental behavior (Yu et al., 2019). Climate change adaptation behaviors can have mitigation and environmental co-benefits (IPCC, 2018), but they are not necessarily interchangeable with pro-environmental behaviors (van Valkengoed & Steg, 2019b). Some pro-environmental behaviors can be adaptive responses to climate change impacts (e.g., installing home insulation to protect the home from temperature changes), but some are not (e.g., recycling). A few of these latter actions were nonetheless named in the publications we reviewed. Therefore, we urge future researchers to carefully consider what consumption behaviors they include when studying personal and household adaptation.

Research from a variety of disciplines has much to offer future scholarship on adaptation behaviors. The type of research we propose, such as examining the links between adaptation behaviors, and their short-term individual and long-term societal outcomes, is likely to be particularly challenging, and thus requires interdisciplinary collaborations. Fortunately, as illustrated by our review, scholars from many different backgrounds are already engaged in relevant research, offering many opportunities to work together. Such efforts will help ensure that these important and urgent questions about adaptation behavior are addressed in holistic ways and increase the likelihood of uptake by policymakers and planners (Irwin et al., 2018).

Limitations and caveats

This work examined how researchers from a broad range of disciplines have defined and operationalized personal and household adaptation behaviors. One limitation of our work is that we did not review research on resilience. Because adaptation and resilience are related (cf.

Nelson, 2011; Pelling, 2011), there may be additional work on resilience behavior that may have contributed to further advancing our understanding of what adaptation behaviors are.

Second, and consistent with Van Valkengoed & Steg's (2019a) meta-analysis and other theoretical literature in this area, we only reviewed research that focused on both individual-level adaptation behaviors and their psychosocial antecedents. As a result, 66 publications that did not address the latter were not included in our review. We do not know how many of these publications might have been included without this criterion because many of them may not have met have the additional inclusion criteria after closer review. Given the consistency between Van Valkengoed & Steg's (2019a, 2019b) results and our review's findings, it is not clear that the inclusion of these additional publications would yield compelling new insights. Nonetheless, a few potentially relevant additional papers may have been excluded.

Lastly, we recognize that raising individuals' awareness about what adaptation behaviors they can engage in will not be sufficient for fostering these actions. Like other individual-level behaviors, adaptation behaviors are not solely determined by knowing what actions are appropriate, but are influenced by a range of psychological, financial, social, institutional, ecological and other factors (Gifford et al., 2011). As such these behaviors will only come about through the use of a variety of interventions and strategies (Steg & Vlek, 2009; Zint & Wolske, 2014). Moreover, we recognize that individual-level behaviors are only one component of a much larger array of strategies, including institutional and infrastructural changes, that are needed to successfully adapt to climate change (Agrawal & Lemos, 2007). Nonetheless, clarity on what personal and household behaviors are adaptive is a critical first step toward promoting and engaging in adaptive actions (Steg & Vlek, 2009).

Conclusion

Climate change is likely to radically change the world in the coming decades. As the impacts of climate change increase and intensify (IPCC, 2014, 2018), a growing number of scholars (Clayton et al., 2016; Swim et al., 2009), including us, believe that policymakers and planners must work together with individuals and communities to foster the adoption of personal and household adaptation behaviors to allow all of us to survive, thrive, and support each other through what will be one of the most significant changes humanity has faced. We have proposed a more comprehensive set of different types of adaptation behaviors, along with a system for classifying these behaviors based on this definition. By introducing a more comprehensive definition of adaptation behavior, as well as identifying a richer number of behaviors than have been introduced to date, we hope to significantly advance research on the topic as well as encourage policymakers and planners to foster and support these behaviors.

CHAPTER 3

Bridging Theory and Practice to Support Personal and Household Adaptation Behaviors[2]

Interest in personal and household adaptation behaviors has grown rapidly in response to the mounting impacts of climate change. Scholars have developed a growing body of research on these adaptation behaviors, including theoretical models, empirical studies, and research syntheses. Practitioners in government, non-profit, education, and other sectors are supporting adaptation behaviors through interventions such as virtual reality simulations of climate change impacts and resilience hubs. This article seeks to advance as well as bridge research and practice by presenting (1) a synthesized framework of adaptation behavior based on analyzing key components of relevant multi-disciplinary research, and (2) an associated typology of interventions used in urban settings. The synthesized framework makes a unique contribution through its holistic approach to linking climate change impacts, contextual factors, psychosocial antecedents, adaptation behaviors, desired outcomes, and feedback loops. As such, it also demonstrates what personal and household behaviors are adaptive and points to what interventions might support these types of actions. The typology classifies interventions based on the extent to which they focus on the contextual or psychosocial determinants of adaptation behavior, illustrated with innovative U.S. based examples. Future research should give greater attention to the contextual influences on adaptation behaviors, and practitioners as well as researchers should consider a greater variety of interventions to achieve adaptation outcomes.

[2] A version of this chapter is currently under review at *Nature Climate Change.*

Introduction

Interest in personal and household adaptation behaviors has grown rapidly in response to the impacts of climate change (IPCC, 2018). Both the Intergovernmental Panel on Climate Change and the United States' national climate change assessments, for example, have called for these types of individual-level adaptation actions (IPCC, 2018; USGCRP, 2018). While consensus on how to define personal and household adaptation behaviors has yet to emerge, they can be reactive or proactive, taken alone or with others in response to climate change impacts and for the purpose of protecting or benefitting individuals engaging in these actions, others, or the environment either in the short- or long-term (Chapter 2). Indeed, scholars from geography (Grothmann & Patt, 2005), public health (Semenza et al., 2011), urban planning (Wamsler & Brink, 2014), psychology (Reser & Swim, 2011), and economics (Botzen et al., 2013) have all contributed to research on these types of adaptation behaviors. This growing, multi-disciplinary body of literature offers definitions and examples of adaptive personal and household behaviors (Chapter 2), theoretical models and empirical studies of personal and household adaptation behaviors (Grothmann & Patt, 2005) as well as meta-analyses and literature reviews (van Valkengoed & Steg, 2019a, 2019b).

Due to the diversity of disciplines involved, scholars have identified a variety of personal and household adaptation behaviors (henceforth *adaptation behaviors*) such as household protection (e.g., reducing impervious surfaces outside one's home), learning (e.g., seeking information about local climate change impacts), and civic engagement (e.g., joining a volunteer group to develop a neighborhood hazard plan; Chapter 2; van Valkengoed & Steg, 2019b). Moreover, consistent with their disciplines, scholars have studied different aspects of these behaviors. Researchers from economics (Botzen et al., 2013) and urban planning (Boswell et al.,

2012; Wamsler & Brink, 2014), for example, have focused on how individuals can limit damage from climate hazard events such as floods or participate in planning processes. Researchers from psychology (Bradley et al., 2014; Helm et al., 2018) have focused on both how to persuade individuals to engage in adaptation behaviors to benefit the environment and on how individuals cope with climate impacts and disruptions. Public health researchers have focused on promoting protective behaviors such as drinking more water and staying indoors in response to heat (Akompab et al., 2013; Semenza et al., 2011) as well as on how social inequalities might affect the hazards that individuals experience (Sampson et al., 2013).

A few scholars have also synthesized select aspects of what has been learned about adaptation behaviors. Van Valkengoed & Steg's (2019a) meta-analysis of adaptation behaviors identified many potential psychological predictors of adaptation behavior and what impacts they might address, but not what outcomes might result from those behaviors. In contrast, Wilson et al.'s (2020) literature review identified psychological antecedents of adaptation behavior and potential outcomes of behavior, but it does not consider which behaviors address which climate change impacts. These different approaches capture different parts of an individual's experience of adapting climate change, but none represent the whole.

Furthermore, the lack of a comprehensive model of adaptation behaviors greatly limits the ability of practitioners in government, non-profit, education, and other sectors, to design effective interventions to support these behaviors (e.g., Lee & Davis, 2019). For example, in response to increased flood risk, an economic approach might suggest financial incentives for individuals to elevate their homes; a planning approach, a participatory community process to evacuation; a psychological approach, mental health programs to reduce stress; and a public health approach, monitoring flood risk and associated community awareness campaigns. Each

might be effective on their own but nonetheless represents a piecemeal approach to achieving not just desired personal but also societal adaptation outcomes.

Another limit of current adaptation behavior research is how little of it has focused on interventions to support adaptation behaviors. In the U.S., for example, the only comprehensive review of climate action plans across the country did not probe into adaptation behavior interventions specifically, and found that only awareness-raising and outreach activities were suggested, along with policy and infrastructure changes (Stults & Woodruff, 2017). A recent review of adaptation behavior research from Europe (van Valkengoed & Steg, 2019b) revealed only three interventions to support adaptation behaviors. These studies examined the effectiveness of informational messaging on psychosocial predictors of adaptation behaviors and were exclusively conducted in laboratories.

In contrast, on-the-ground practice to support adaptation behaviors appears to be evolving in diverse ways, based on evidence from the United States. For example, the Community Leadership on the Environment, Advocacy & Resilience (CLEAR) program in Miami-Dade County, FL, offers a multi-week formal education program that teaches residents about local climate change impacts and offers training in advocacy and community organizing skills for developing local climate action solutions (Catalyst Miami, 2017). The city of Lakewood, CO, provides funding and support for community-based initiatives, such as resilience circles (i.e., small groups of individuals learning together about local climate change impacts and providing each other mental health and other material support; Sustainable Neighborhood Network, 2015). U.S. mental health professionals are developing practices to specifically help individuals cope with the mental health impacts of climate change (e.g., Climate Psychiatry Alliance, 2018). The Urban Sustainability Directors Network (USDN) is working with cities to develop resilience

hubs to both serve as emergency shelters and support long-term personal and community capacity for adaptation and civic engagement (Baja, 2018). Federal and state programs that fund migration away from flooding hazard zones (ELI & UNC-EI, 2017), as well as disaster aid organizations like the Red Cross (American Red Cross, 2019), are no longer only responding to short-term emergencies but are also seeking to support long-term adaptation. Other programs are reorienting emergency preparedness (Phadke et al., 2015) and citizen science (Hoffman, 2020) interventions toward civic engagement to address climate change adaptation.

Despite the richness of these examples, to the best of our knowledge, they are not well known in adaptation behavior scholarship. For example, they have not been mentioned in key reports such as the 4th National Climate Assessment (Lempert et al., 2018), which names specific behaviors that individuals can take in their day-to-day lives to respond to climate change impacts, such as purchasing flood protections and creating home emergency kits, but does not suggest any interventions to support these behaviors. The U.S. Climate Resilience Toolkit mentions a few behaviors such as going to cooling centers during heat waves (U.S. Federal Government, 2019) or participating in community adaptation planning (U.S. Federal Government, 2017), but it does not provide systematic or detailed information about what kinds of behaviors might be included in adaptation planning or how they might be supported.

In light of the limitations of existing research and practice, the purpose of this article is to synthesize what is known about adaptation behavior across the dispersed, multi-disciplinary scholarship on the topic, and to do so in a way that bridges research and practice. We present (1) a model linking climate change impacts, contextual factors, psychosocial antecedents, adaptation behaviors, desired outcomes, and feedback loops, and (2) an associated typology of interventions classified based on the extent to which they focus on contextual or psychosocial determinants.

The latter are illustrated with examples from the U.S., in part because of the great range of climate impacts the country is experiencing across and within geographic locales (USGCRP, 2018). Thus, while the U.S. is not representative of all other national contexts, it may offer examples that will be relevant for different climate change impacts and geographies.

Toward a synthesized framework of personal and household behavior

Our synthesized framework (Figure 3-1) is based on nine key publications on adaptation behavior published by authors from psychology (Clayton et al., 2015; Reser & Swim, 2011; van Valkengoed & Steg, 2019a), geography (Grothmann & Patt, 2005; Koerth et al., 2017). development (Brown & Westaway, 2011), and sustainability studies (M. Hamilton et al., 2018; Oakes et al., 2016; Wilson et al., 2020). These publications were selected because they present full theoretical models of adaptation behavior, rather than only selected predictors, as have been included in previous literature reviews (van Valkengoed & Steg, 2019a; Wilson et al., 2020), including our own (Chapter 2). As shown in Table 3-1, existing adaptation behavior models identify important elements and relationships among them, but none do so in a similarly comprehensive and holistic way. We begin with describing the individual models on which our synthesized framework is based, followed by a description of its core features.

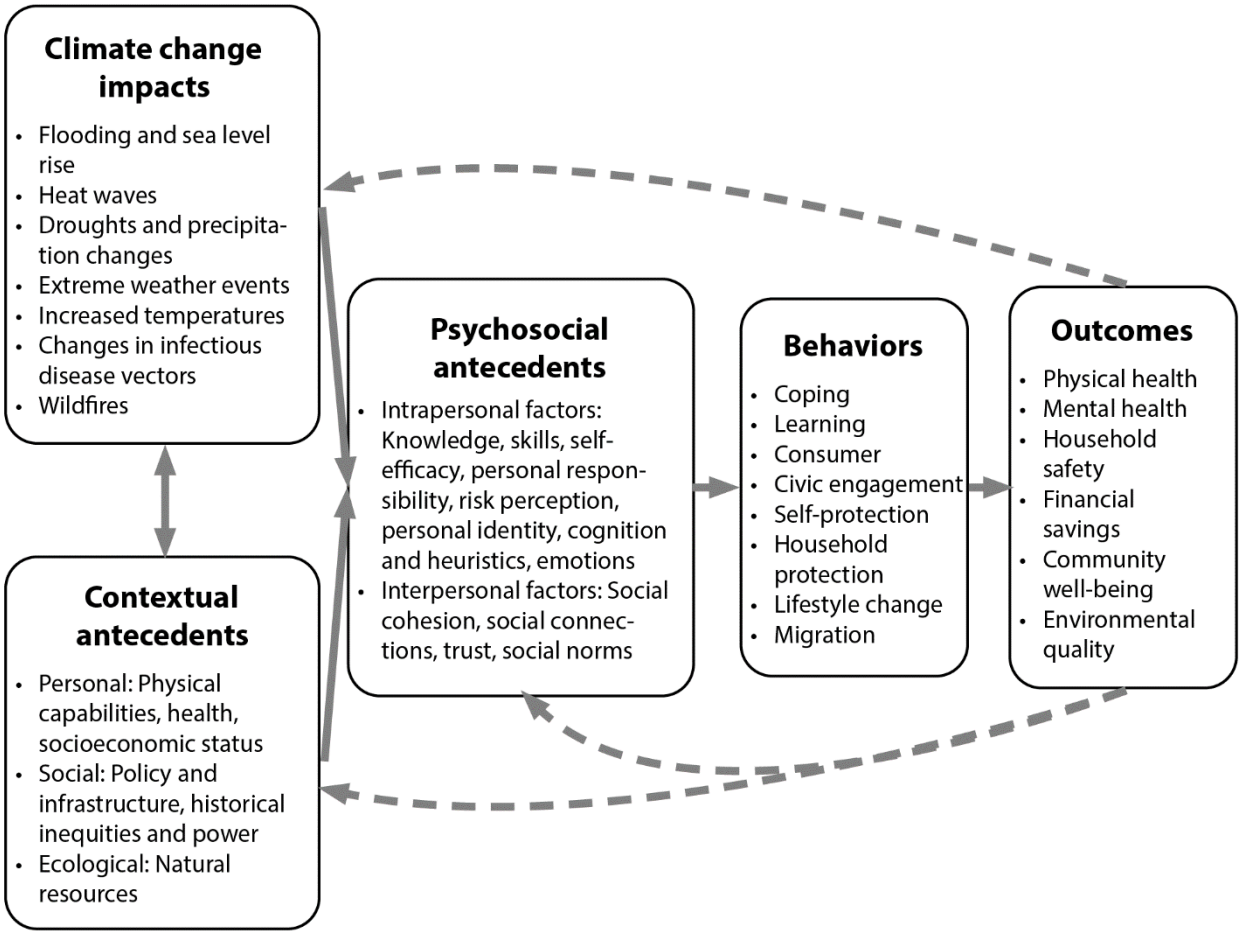


Figure 3-1. Synthesized framework of personal and household adaptation behavior

Table 3-1. Comparison of components included in existing personal and household adaptation behavior models

Citation name	Grothmann & Patt 2005[a]	Brown & Westaway 2011	Reser & Swim 2011	Clayton et al. 2015	Oakes et al. 2016	Koerth et al. 2017	Hamilton et al. 2018	Van Valkengoed & Steg 2019a	Wilson et al., 2020
Climate change impacts			X	X	X	X	X	X	
Contextual antecedents	X	X	X	X		X			
Psychosocial antecedents	X	X	X	X	X	X	X	X	X
Adaptation behaviors	X	X	X	X	X	X	X	X	X
Adaptation outcomes			X				X		X
Feedback Loops			X	X			X		

[a] Related models such as Kuruppu & Liverman (2011). and Dang et al. (2012). would also be classified as including these same components.

The earliest model of adaptation behavior, Grothmann & Patt's (2005) Process Model of Proactive Private Adaptation to Climate Change (PMPPACC), is based on Protection Motivation Theory (Rogers, 1975, 1983). This model suggests that contextual factors (e.g., social discourse, time, money, and social support) and psychosocial antecedents (e.g., climate change risk appraisal, personal adaptation appraisal) predict individuals' likelihood of taking adaptive or maladaptive adaptation behaviors. Subsequent researchers have slightly adjusted this model by adding psychosocial antecedents such as heuristics (Kuruppu & Liverman, 2011) as well as social norms and habits (Dang et al., 2012).

Brown & Westaway (2011) reviewed several conceptual frameworks of individual-level adaptive capacity in the contexts of human development, resilience, and disaster recovery. They suggest that individual-level adaptive capacity is determined by agency (i.e., psychosocial antecedents), as well as resources and the ability to deploy them (i.e., contextual antecedents).

Reser & Swim (2011) present a model of climate change coping responses (i.e., behaviors) driven by direct and indirect climate threats (i.e., climate change impacts), characteristics of the individual, physical environment, and community (i.e., contextual antecedents), cognitive appraisals and interpretive and motivational responses (i.e., psychosocial antecedents). They also include feedback loops to account for outcomes affecting future adaptation behaviors. Relative to other existing adaptation behaviour models, this is one of the most comprehensive. However, it includes relatively few specific predictors, behaviors, and outcomes when compared to more recent models such as those by van Valkengoed & Steg (2019a) and Wilson et al. (2020).

Clayton et al.'s (2015) schematic model is similar to but more parsimonious than the Reser & Swim's (2011). It argues that climate change (i.e., impacts) affects and is affected by

personal and household behaviour. The latter is, in turn, expected to be affected by perceptions and personal well-being (i.e., psychosocial antecedents, feedback). Climate change impacts on all three factors are mediated by social processes including institutions and policies (i.e., contextual antecedents).

Oakes et al. (2016) present a model of individual psychological and behavioral adaptation to forest diebacks (i.e., climate change impacts) based on a qualitative study. They argue that these types of adaptation behaviors are affected by knowledge, attachment, and use values (i.e., psychosocial antecedents).

Koerth et al. (2017) conducted a literature review to identify geographic variables, situational variables, and socioeconomic variables (i.e., contextual antecedents), as well as cognitive factors (i.e., psychosocial antecedents) that have been linked to personal adaptation behavioral intentions and actual behaviors in the context of coastal flooding (i.e., climate change impacts).

Hamilton et al. (2018) present a model of behavioral adaptation based on empirical research of homeowners' actions to protect their homes from forest wildfires (i.e., climate change impacts). They suggest that the effects of biophysical drivers of hazard conditions and adverse or beneficial impacts of climate change (i.e., climate change impacts) on behavior, are mediated by psychological and social processes (i.e., psychosocial antecedents). They argue that there are feedbacks among these various factors over time and suggest that behaviors affect subsequent climate hazard conditions (i.e., outcomes, feedbacks).

Two recent literature reviews synthesize results across empirical research designed to identify predictors and outcomes of adaptation behaviors. Van Valkengoed & Steg's (2019a) meta-analysis identifies motivators (i.e., psychosocial antecedents) of adaptation behavior, as

well as the climate related hazards (i.e., climate change impacts) these motivators have been linked to. Wilson et al.'s (2020) most recent review similarly focuses on the psychosocial antecedents of adaptation behaviors and distinguishes among intra- or interpersonal motivators. They also suggest that adaptation behaviors can result in incremental (i.e., short-term, personal) or transformative (i.e., long-term, social) outcomes.

In the following sections, we focus on each one of the core components synthesized from these models. Each component is described in greater detail, to explain why it is critical for researchers and practitioners to consider in their respective work.

Climate change impacts

Personal and household adaptation behaviors are situationally specific; they depend on the climate change impacts they are intended to address. Climate change impacts are the climate-related hazards and ecological changes that affect individuals' lives, including short-term events like wildfires and extreme weather, as well as long-term changes such as sea level rise and seasonal temperature changes. Adaptation requires engaging in behaviors appropriate for specific climate change impacts (Clayton et al., 2015; M. Hamilton et al., 2018; Lempert et al., 2018). For example, an individual may move furniture to higher floors to protect it from flooding, but those actions are not adaptive during a heat wave.

Climate change impacts are specifically named in several of the theoretical publications we reviewed (Clayton et al., 2015; Hamilton et al., 2018; Reser & Swim, 2011; van Valkengoed & Steg, 2019a). Impacts were also implicitly included in two publications (Koerth et al., 2017; Oakes et al., 2016), each of which focused only on behaviors in the context of one specific impact (namely, forest dieback and flooding; Oakes et al., 2016; Koerth et al., 2017). Although we list this factor first, we recognize that climate change impacts are not exogenous. Instead, as

we discuss in more detail below, they affect and are affected by other factors over time.

Contextual antecedents

Our synthesized framework depicts contextual antecedents and climate change impacts as interacting factors. Contextual antecedents are not internal to an individual's psychology but instead affect what kinds of behaviors they can perform, i.e., their opportunities for behaviors (Swim et al., 2009) and vary across individuals and groups (Adger et al., 2005). Considering context is critically important because different people might want to carry out an adaptation behavior but be unable to do so because of contextual factors. For example, an individual may want to move out of an area of high flood risk but cannot afford lower-risk housing.

Relatively few of the publications we reviewed explicitly considered contextual factors (Brown & Westaway, 2011; Grothmann & Patt, 2005; Koerth et al., 2017; Reser & Swim, 2011). In addition, they varied in which specific factors they identified and in what they called them. Grothmann & Patt (2005), for example, describe contextual factors as "objective adaptive capacity," (Grothmann & Patt, 2005, p. 204) whereas Koerth et al. (2017) use "nonpersonal variables." (Koerth et al., 2017, p. 8). In these publications, contextual antecedents included socioeconomic status and homeownership (Grothmann & Patt, 2005; Koerth et al., 2017); geographic location (Koerth et al., 2017; Reser & Swim, 2011) and existing social support structures (Brown & Westaway, 2011; Reser & Swim, 2011). They also included longer-term socioecological factors such as existing policies and governance structures (Grothmann & Patt, 2005; Koerth et al., 2017) as well as location of hazards and past ecological disturbances (Hamilton et al., 2018; Koerth et al., 2017; Reser & Swim, 2011).

What these contextual antecedents have in common is that they are forces external to an individual that also exist independently of a change impact, but nonetheless can affect an

individual's behavior to respond to that impact. Contextual antecedents interact with climate change impacts, so that contextual factors may worsen (or lessen) negative climate change impacts and vice versa. This in turn affects the adaptation behaviors individuals can engage in. For example, a major storm event (i.e., impact) may damage housing and infrastructure, especially in places where housing and infrastructure are already in poor condition (i.e., context). The additional expense from flooding damage increases existing costs of repairs, which can cause repairs to be further delayed, leaving the housing and infrastructure even more vulnerable to damage from future storm events. This damage limits the safe places where individuals can go during the next event. Contextual antecedents serve to limit individuals' adaptation behavior options; based on these options, individuals then choose a behavior based on psychosocial antecedents.

Psychosocial antecedents

We argue that psychosocial antecedents serve as a mediating variable between climate change impacts, contextual antecedents, and adaptation behavior. Psychosocial antecedents are psychological and social factors that predict an individual's behaviors. They might include cognitive factors (e.g., knowledge), affective factors (e.g., emotions), or interpersonal factors (e.g., trust). Researchers have identified numerous psychosocial predictors of personal and household adaptation behavior, and generally, behavior change research has historically focused on these antecedents as the most important predictors of behavior change (e.g., Hines et al., 1987; Rogers, 1983; P. C. Stern, 2000). Not surprisingly, therefore, all the models and studies we reviewed named psychosocial antecedents. Nonetheless, they varied in which psychosocial antecedents they described. Van Valkengoed & Steg (2019a) for example, identified trust, personal experience, and social norms, among others. Wilson et al. (2020) classify these

antecedents into intrapersonal (e.g., perceived self-efficacy, perceived personal responsibility) and interpersonal factors (e.g., social networks, social cohesion). Several publications included risk perception or associated factors such as threat appraisal and coping appraisal (Grothmann & Patt, 2005; Hamilton et al., 2018; Koerth et al., 2017; Wilson et al., 2020). Others name procedural knowledge and skills (Brown & Westaway, 2011; Oakes et al., 2016; Reser & Swim, 2011) personal and political identity (Clayton et al., 2015), cognition and information processing (e.g., heuristics; Clayton et al., 2015), place attachment (Oakes et al., 2016; van Valkengoed & Steg, 2019a), and habits (Reser & Swim, 2011).

We suggest that psychosocial antecedents should be considered subsequent to climate change impacts and contextual antecedents in the model rather than predictive of them. This is because psychosocial antecedents are affected by both climate change impacts (i.e., they are specific to what events and changes are happening) and contextual antecedents, which limit possible response options. In summary, psychosocial antecedents, including perception of climate change impacts and contextual factors, guide the adaptation behaviors individuals will engage in (Grothmann & Patt, 2005; Hamilton et al., 2018).

Behavior

Behaviors are generally the dependent variable of behavior change theories (e.g., Ajzen, 1991; Hines et al., 1987; Rogers, 1983) and thus, are a critical component of the comprehensive framework. Indeed, this factor is named in all the theoretical papers we reviewed. Many kinds of personal and household behaviors are possible, and a recently published literature review identified coping, learning, household protection, self-protection, civic engagement, consumer action, lifestyle change, and migration behaviors as the most common types (Chapter 2).

Outcomes

Although most behavior change theories consider behavior itself to be the final dependent variable, in adaptation, we and others argue that behavioral outcomes should be considered the dependent variable instead (Chapter 2; Wilson et al., 2020). This is because the same behavior can lead to different adaptation outcomes. For example, migration might support financial savings or land conservation outcomes (e.g., ELI & UNC-EI, 2017). Yet migration has also been linked to reduced personal and social well-being among the individuals who moved (Binder et al., 2019). Thus, outcomes, not the behaviors themselves, determine whether a behavior is adaptive (i.e., successfully addresses an adaptation problem) or maladaptive (i.e., does not).

Few existing adaptation behavior models or studies explicitly consider the outcomes of adaptation behaviors (van Valkengoed & Steg, 2019a; Wilson et al., 2020). When they do, most research focuses on private, personal outcomes rather than collective, societal outcomes (Wilson et al., 2020). Consistent with our synthesized framework, Wilson et al. (2020) argue that future adaptation behavior research should put greater emphasis on targeting long-term outcomes. Our own review of personal and household adaptation behavior research differs in that we found almost no studies that measured behavioral outcomes and that most appeared to assume that adaptation behaviors would result in positive outcomes (Chapter 2). In other words, there has been a lack of recognition in adaptation scholarship that behaviors might not lead to desired outcomes, and that these outcomes may vary. We argue that it is critical to consider desired adaptation outcomes to increase the likelihood that the supported behaviors contribute to short- and/or long-term adaptation goals.

Feedback

Our synthesized framework includes feedback, because outcomes affect future climate

change impacts, contexts, and psychosocial antecedents, and thus, behaviors over time (Hamilton et al., 2018; Reser & Swim, 2011). For example, during a brush fire (impact) a homeowner who has a safe place to go (contextual antecedent) might perceive the fire as risking harm to herself (psychosocial antecedent), and thus might evacuate (behavior) resulting in protecting herself (outcome). Afterward, because she was able to escape this fire unharmed (outcome), she would have the ability and motivation to invest in home fire protections, migrate to a new home further from the fire risk area, or get involved in community decision-making (behaviors) around fires (impact) because she recognizes fires are a long-term threat and she cares about protecting her community (psychosocial antecedent). Whether a person can purchase protections, move, or get involved in community decision-making depends on her physical abilities, financial ability to move, and being in a community that provides opportunities for meaningful involvement (contextual antecedents). All these actions might result in reduced likelihood of harm from fires (outcomes), but the adaptation behaviors themselves may differ based on different motivations. Feedback is thus incorporated into the model to capture how these factors may impact each other and change over time.

Associated personal and household adaptation behavior interventions

Our framework synthesizes not only key insights from adaptation behavior research, but also can be used by practitioners to select and design interventions to support adaptation behaviors as part of the planning step of the adaptation management process (Lempert et al., 2018). In other fields, behavior change theories have long been closely linked to intervention practice (Schultz, 2014; M. J. Stern, 2018). For example, in public health (Janz & Becker, 1984; e.g., Rogers, 1975, 1983) and environmental sustainability (Schultz, 2014; M. J. Stern, 2018). In contrast, we are not aware of this being the case for adaptation behavior interventions. *Adaptation behavior*

interventions refer to programs designed and implemented governments, educators, and other organizations to support actions that can contribute to adaptation outcomes. The underlying assumption is that adaptation behaviors would not occur without these interventions. Aligning practice with theory should improve program effectiveness by helping practitioners anticipate which interventions will be more likely to lead to desired outcomes (Schultz, 2014; M. J. Stern, 2018).

First, we connect our framework to practice by drawing on Steg & Vlek's (2009) two overarching categories of adaptation behavior interventions: structural and informational. Structural interventions are "aimed at changing the circumstances under which behavioral choices are made," (Steg & Vlek, 2009, p. 313) also referred to as opportunities (Swim et al., 2009), while informational interventions are "aimed at changing prevalent motivations, perceptions, cognitions and norms," (Steg & Vlek, 2009, p. 313) also referred to as motivations (Swim et al., 2009). These two categories can be linked to the contextual and psychosocial antecedents, respectively, in the framework (Figure 3-2). A policy change, for example, is a structural intervention aimed at changing contextual factors, whereas messaging to increase risk perception is an informational intervention aimed at changing psychosocial antecedents.

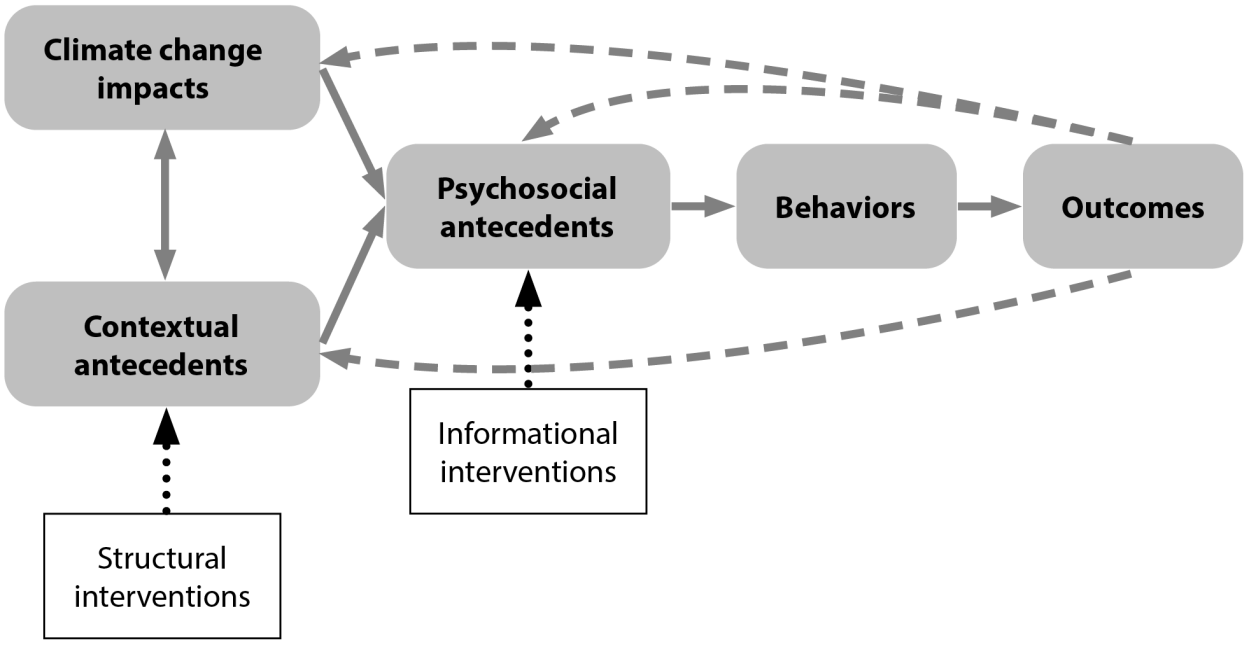


Figure 3-2. Conceptual illustration mapping major categories of behavioral interventions to synthesized framework components

Next, to demonstrate how practitioners might select and design interventions, we offer a typology of adaptation behavior interventions, describe how they relate to our framework, and provide real-world, illustrative examples of programs currently implemented in the U.S. (Table 3-2). Rather than consisting of binary categories, we suggest that structural and informational adaptation behavior interventions fall along a continuum (Figure 3-3). While our typology is unlikely to be inclusive of all potential adaptation behavior interventions, it significantly expands upon the types addressed in adaptation scholarship to date (i.e., infrastructure changes, financial incentives, information provision).

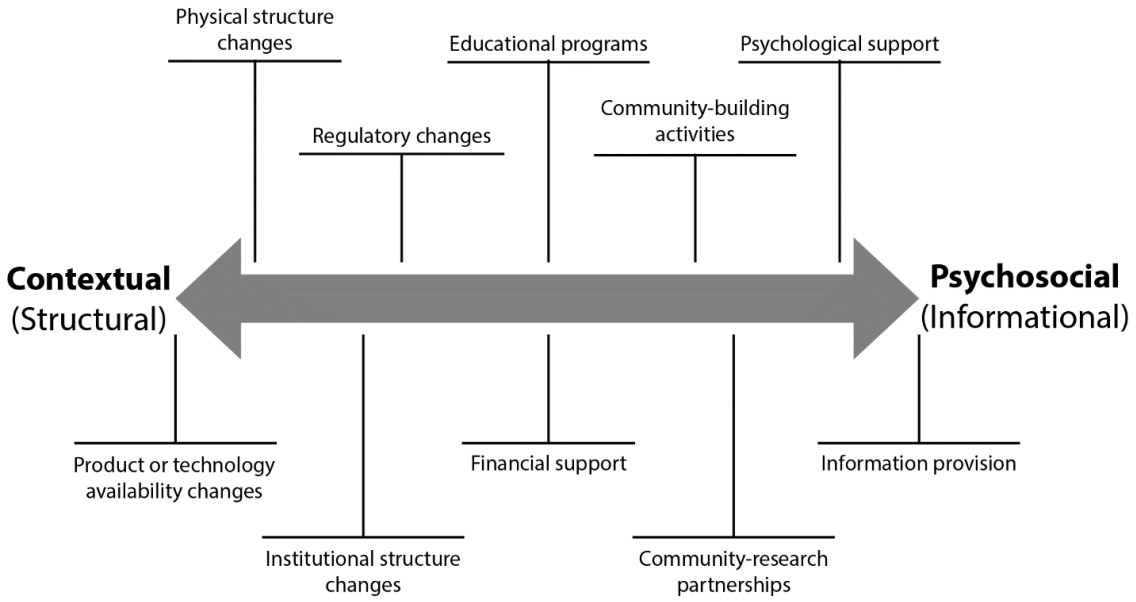


Figure 3-3. Conceptual illustration of intervention types mapped onto a continuum of contextual (structural) and psychosocial (informational) intervention types

Intervention typology

Structural interventions seek to change something outside any single person's or group's control that enables or limits them from taking action (i.e., whether a person *can* take an action). A review of climate action plans demonstrated that structural interventions are a common type of adaptation strategy in the U.S. (Stults & Woodruff, 2017) but these interventions rarely include an explicit focus on desired behaviors. Instead, behavior change is often an assumed result of these interventions. For example, a policy change to strengthen building codes by requiring that houses be more able to withstand extreme events assumes that property owners will comply by taking on actions such as improving their home foundations. Structural interventions include policy, institutional structure, and infrastructure changes, as well as changes in the products or technologies that are made available. U.S. examples include changes to residential building codes to reduce damage from increased winds and severe weather events in Moore, OK (i.e., policy change; Ripberger et al., 2018); use of a neighborhood consensus conference model to develop community-level emergency preparedness plans in St. Paul, MN (i.e., institutional

structure change; Phadke et al., 2015); development of resilience hubs in Baltimore, MD, and across the U.S. (i.e., physical structure change; Baja, 2018); and disaster relief and humanitarian aid by the American Red Cross to support climate resilience (i.e., product and technology availability; American Red Cross, 2019).

Informational interventions refer to programs that attempt to change internal or interpersonal factors that influence an individual or group's motivation to act (i.e., whether a person *wants* to take an action). In contrast to structural interventions, informational interventions explicitly seek behavior change and often target specific behaviors (McKenzie-Mohr, 2000; Schultz, 2014; Steg & Vlek, 2009). Interventions of this type include information provision, psychological support, community-building activities, and community-research partnerships. Information provision, also referred to as awareness-raising, is the most commonly identified type of informational intervention to support adaptation behaviors in the U.S. (Stults & Woodruff, 2017). U.S. examples include Look Ahead San Francisco and Look Ahead Marin's virtual reality simulations of local sea level rise (i.e., information provision; Moser et al., 2016); development of mental health support groups such as the Good Grief Network (Good Grief Network, n.d.) and other therapeutic practices related to mental health impacts of climate change (i.e., psychological support; Climate Psychiatry Alliance, 2018); development of community programs such as resilience circles to share resources and skills (i.e., community-building activities; Sustainable Neighborhood Network, 2015); and citizen science programs to map how heat waves affect different areas of Richmond, VA and Washington, DC (i.e., community-research partnerships; Hoffman, 2020).

We place financial support at the center of the continuum of structural and informational interventions. This is because financial support can target either contextual or psychosocial

antecedents depending on the target adaptation behavior. For consumer behaviors, household protection, migration, or other adaptation behaviors where the cost of acting may be high, financial support can address the contextual factors of limited access and ability to pay for needed equipment such as insulation or roofing (Schultz, 2014). For behaviors such as civic engagement or learning, financial support provides extrinsic motivation (i.e., psychosocial antecedent) to act; however, this strategy runs the risk of no longer having an effect after support is withdrawn (Agrawal et al., 2015; De Young, 1993). U.S. examples include floodplain buyouts, in which local, state, or federal governments provide financial support for individuals who have experienced flooding. The program pays individuals the pre-flood market value of their home to enable them to move to a new home (Binder et al., 2019; ELI & UNC-EI, 2017).

Educational programs are also placed in the center because they might target both psychosocial antecedents, such as knowledge and attitudes, as well as contextual factors, such as social capital (Bandura, 1978; Kollmuss & Agyeman, 2002). In climate adaptation plans, educational programs are sometimes mentioned as a strategy to build adaptive capacity (Stults & Woodruff, 2017), but little additional detail is provided. Education programs can take many forms, including formal classroom programs and informal exchanges, and they can support adaptation behaviors through targeted instruction or life-long learning (Wals, 2007; Winther et al., 2010). What these programs have in common, however, is an emphasis on interaction and feedback or learning assessment rather than information provision alone. One U.S. example is the Community Leadership on the Environment, Advocacy & Resilience (CLEAR) program in Miami-Dade County, Florida. CLEAR is a multi-week, classroom-based program that teaches diverse Miami residents about climate science, how climate change will impact Miami, and skills to advocate for local climate adaptation action (Catalyst Miami, 2017).

Table 3-2a. Descriptions and examples of structural *adaptation behavior interventions (i.e., focusing on contextual antecedents)*

Intervention type	**Description**	**Example program**	**Organization**	**Program description**	**Location**	**Year started**	**Citation**
Product or service availability	Changing the products, technologies, or services available to individuals to aid in an individual's ability to predict, prevent, or respond to climate change impacts	Disaster relief	American Red Cross	Provision of food, water, shelter, and other necessities in the immediate aftermath of a disaster	Global	1881	American Red Cross, 2019
Physical structure change	Changing physical structures such as new buildings or infrastructure that provide space and/or equipment for individuals to take on new adaptation behaviors	Resilience hubs	City of Baltimore & Urban Sustainability Directors Network	Use existing community building to serve as neighborhood center for both day-to-day community resilience-building and a place to go during emergencies	Baltimore, MD (existing), nationwide (in development)	2018	Baja, 2018
Institutional structure change	Changing decision-making structures (e.g., new organizations or groups). involving public participation to develop new adaptation plans and policies	Ready & Resilient Communities emergency preparedness program	Macalester College, Science Museum of Minnesota & City of Saint Paul	City and local science museum worked with residents to plan for different climate events	St. Paul, MN	2014	Phadke et al., 2015
Regulatory change	Changing laws or regulations related to what adaptation behaviors an individual is required or encouraged to take	Zoning and building code changes	City of Moore	Stricter requirements for new home construction to protect homes from higher winds and storms	Moore, OK	2014	Ripberger et al., 2018

Table 3-2b. Descriptions and examples of cross-cutting interventions (i.e., focusing on both contextual *and* psychosocial *antecedents)*

Intervention type	**Description**	**Example program**	**Organization**	**Program description**	**Location**	**Year started**	**Citation**
Educational programs	Developing knowledge, skills, or attitudes to take on new adaptation behaviors, through individual or social learning	Community Leadership on the Environment, Advocacy & Resilience (CLEAR)	Catalyst Miami	Multi-week intensive training program for Miami residents on community climate impacts, resilience, and advocacy strategies to support local and state climate policy change	Miami, FL	2016	Catalyst Miami, 2019
Financial support	Offering financial rewards (e.g., rebates, discounts). or support (e.g., subsidies). for financial decisions related to preventing or responding to climate hazards	Flooding buy-out programs	Local governments and Federal Emergency Management Agency (FEMA)	Residents in floodplains are offered funding to move out of their current home after a flooding disaster	Nationwide	1993	ELI & UNC-EI, 2017

Table 3-2c. Descriptions and examples of informational *interventions (i.e., focusing on psychosocial antecedents)*

Intervention type	**Description**	**Example program**	**Organization**	**Program description**	**Location**	**Year started**	**Citation**
Community building activities	Collaborating as a group to achieve a common objective (without a formal research component). related to preventing, responding, or adjusting to climate change impacts	Resilience Circle (Sustainable Neighborhoods Program)	City of Lakewood	City provides funding for citizen-led initiative to provide mutual aid, support, and education related to climate change impacts	Lakewood, CO	2012	Sustainable Neighbor-hood Network, 2015
Community-research partnerships	Partnerships where researchers and community members collaborate to collect data on local climate change impacts	Richmond, VA urban heat island mapping citizen science program	Science Museum of Virginia & Portland State University	Residents collected temperature data and thermal images in/around Richmond and Washington DC at multiple times of day during a heat wave to determine which neighborhoods experienced most and least extreme heat and why	Richmond, VA; Washington, DC	2017	Hoffman, 2020
Psychological support	Providing therapy for individuals (one-on-one or through groups). to help manage mental health impacts associated with climate change	Therapy	Climate Psychiatry Alliance	Therapists focused on addressing grief related to climate change	Nationwide	2018	Climate Psychiatry Alliance, 2018
Information provision	Providing information about a climate change impact and/or actions that an individual can take to address that impact	Look Ahead San Francisco/ Marin virtual reality program	Climate Access	Participants experience simulations of sea level rise in selected local places using phones or viewing stations, and then can receive or exchange information about potential adaptation actions	San Francisco & Marin, CA	2015	Moser et al., 2016

Implications

Future research

Our model of personal and household adaptation behavior makes two important scholarly contributions. First, by synthesizing existing research, this model is more comprehensive than existing frameworks of adaptation behavior (e.g., Grothmann & Patt, 2005; Koerth et al., 2017). While all the components of our model were included in at least one existing paper, as we illustrated, the papers varied in which components they included and how those components related to each other. This suggests a lack of communication among researchers in this emerging research field. For one, most existing adaptation behavior frameworks have focused almost exclusively on psychosocial factors (e.g., Rogers, 1983; Hines et al., 1987; Ajzen, 1991) and not on contextual influences (Gifford & Nilsson, 2014; Kollmuss & Agyeman, 2002). This is problematic because climate change impacts individuals differently and often unequally, depending on their personal, social, and ecological contexts (IPCC, 2014; USGCRP, 2018). Thus, designing an adaptation intervention without considering context means that the intervention may not be appropriate. For example, providing individuals with a map of cooling centers to go to during a heat wave may not be useful if they do not have a way to get there. Moreover, even existing adaptation behavior models that include contextual and psychosocial antecedents do not necessarily consider how they interact. Continuing the example above, a community cooling center must be both easy to access (i.e., address contextual factors) and trusted to be a safe place (i.e., address psychosocial factors). Our synthesized framework is meant to facilitate future interdisciplinary communication so that all these components will be considered.

In addition, our synthesized framework provides guidance for determining which behaviors are and are not adaptive in responding to climate change. While many kinds of adaptation behaviors are possible, it is not necessarily clear which behaviors should be enacted. Our theory suggests that behaviors are adaptive when they are appropriate responses to specific climate change impacts, are achievable within the context at hand, and achieve desired adaptation outcomes. Individuals select these behaviors based on psychosocial antecedents. For example, individuals may respond to flooding by stockpiling sandbags, or by moving away from a floodplain altogether. The adaptive behavior is the one that supports an individual's future safety and well-being (Anderson et al., 2018; Binder et al., 2019). It may be that an individual feels a greater attachment to their home and community (i.e., psychosocial antecedents) or has better access to needed funding and supplies (i.e., contextual antecedents) in their current home rather than somewhere else – or it may be the case that an individual has family out of town and fears experiencing a flood again. Staying in place may be more adaptive in the former case and moving may be more adaptive in the latter case (Binder et al., 2019). Given how many adaptation behaviors and outcomes are possible (Chapter 2) our theory helps researchers explain why a behavior may or may not achieve a desired adaptation outcome and thus, provides unique guidance for selecting and designing adaptation behavior interventions.

Considerations for selecting and designing adaptation behavior interventions

There are many possible behavioral interventions that practitioners or researchers may choose to achieve desired adaptation outcomes. Regardless of the type of intervention selected, however, we argue that all components of our synthesized framework should be considered. This recommendation follows strategies such as community-based social marketing, which begins with selecting a desired behavior to target, then includes gathering information about relevant

contextual and psychosocial antecedents influencing this behavior, and finally selecting a particular strategy based on these findings (McKenzie-Mohr, 2000; Schultz, 2014).

Here, we present step-by-step guidance for how practitioners might integrate this model into overall intervention design (Box 3-1). First, to determine adaptation behavior is which action to target, we recommend considering behaviors that are appropriate to specific, relevant climate change impacts. Broader scholarship on climate change adaptation recommends that adaptation strategies should be impact specific (Lempert et al., 2018), but we highlight this step because not all existing adaptation behavior frameworks included this component. Next, as suggested throughout and in departure from most existing adaptation behavior scholarship, we also argue that practitioners consider the desired outcomes adaptation behaviors are expected to contribute to, as well as the context in which they are enacted. This recommendation is consistent with backward design (Wiggins & McTighe, 2005), which suggests that outcome-focused interventions are more effective than ones solely focused on behavior, and it acknowledges the critical influence of physical, social, and environmental influences on adaptation behaviors. Based on this information, a practitioner can then determine relevant behaviors, psychosocial antecedents, and intervention designs.

Additionally, rather than practitioners choosing which adaptation behaviors to support in a top-down way, we suggest choosing them in collaboration with target individuals, groups, or communities (Zint & Wolske, 2014). Participatory approaches to intervention design are well known in other planning contexts (e.g., Boswell et al., 2012; Wondolleck & Yaffee, 2000) and may be more likely to result in the selection of behaviors that target audiences are willing and able to engage in. Such collaborative approaches have been used to select short-term emergency preparedness behaviors in St. Paul, MN (Phadke et al., 2015) and long-term adaptation behaviors

in Geraldton, WA, Australia (Zint & Wolske, 2014).

Box 3-1. Hypothetical example of program design using the synthesized framework and typology of interventions

Example: A local government is developing a program to protect local residents from increased riverine flooding events.

Step 1: Identify impacts
Increased flooding caused by more frequent and intense rain events.

Step 2: Identify desired outcomes
Reduce financial losses from property damage, morbidity and mortality from flooding events, as well as increase the community's sense of safety from flooding risks.

Step 3: Identify relevant contextual factors
The entire city has experienced a major flood event (including loss of life) in the last year. The area of the city with the highest flood risk is also the only area with affordable housing. Much of the housing and stormwater infrastructure is aging and not well maintained. Many of the residents are low-income people of color who have lived in the neighborhood their entire lives, and are a close-knit community.

Step 4: Identify desired behaviors
Based on discussions with the community, the city determines that asking residents to move away is not feasible or acceptable to residents. Instead, desired behaviors include learning about flood warning systems, creating home emergency preparedness kits, taking action such as moving household equipment and furniture to higher floors, and engaging residents in processes to develop flooding evacuation maps and prioritize infrastructure repairs.

Step 5: Identify relevant psychosocial antecedents
The residents have low trust in the local government, but high trust in each other. They also are highly concerned about the future likelihood of floods (high risk perception) but do not know how to reduce personal risk and feel uncertain about how to protect themselves (i.e., self-efficacy).

Step 6: Determine which antecedents to target (psychosocial, contextual, or both)
Contextual factors include improvements to stormwater infrastructure and creating physical spaces to which to evacuate. Psychosocial factors include increasing resident trust in the city government, as well as knowledge and self-efficacy regarding personal flood protection.

Step 7: Select intervention type(s)
Interventions may include development of a new decision-making collaborative with residents (i.e., institutional structure change) to lead and inform above efforts; improvements to stormwater infrastructure and development of evacuation facilities (i.e., physical structure changes); events to build trust in government (i.e., community-building activities); and workshops for residents to learn how to develop evacuation plans and home emergency kits, as well as make improvements to their homes to prevent flooding damage (i.e., educational programming).

Because many interventions exist and different interventions meet different situational

needs, a combination of strategies is likely to be most effective for meeting adaptation goals. For example, resilience hubs can provide physical spaces (structural intervention) for emergency shelter and community gatherings, offer training programs (education), distribute preparedness handouts (information provision), and emergency equipment (product and technology availability; Baja, 2018), all designed to support adaptation behaviors to achieve a range of short and long-term adaptation outcomes. Alternatively, a citizen science program (i.e., community-research partnership) might achieve greater impact if it coordinated with a new collaborative decision-making body (i.e., institutional structure change). This is consistent with research in other domains, which has suggested that there is likely no single best behavioral intervention (Osbaldiston & Schott, 2012). Moreover, because both contextual and psychosocial antecedents affect adaptation behavior, an intervention that targets only one might be ineffective if it ignores the other altogether. For example, a handout encouraging individuals to talk to their neighbors about flood preparation (i.e., information provision) might not be useful if all the neighborhood's storm drains are in poor condition (i.e., contextual factors). Conversely, building cooling centers for use during heat waves (i.e., physical structure change) might not be useful if individuals believe they are safer at home (i.e., psychosocial factors). Including multiple types of interventions can address these multiple factors.

Given limited resources, it may be most useful for practitioners to conduct these interventions at the local scale and collaborate with each other to achieve collective adaptation impact (Kania & Kramer, 2011). Virtually all of the example programs were local in geographic scale. Some programs might be national in scope, such as the USDN's resilience hubs program, but are implemented in only one location at a time (Baja, 2018). This scale of intervention aligns both with the tendency of climate change impacts to vary on small geographical scales, as well

as with the role of local organizations and governments as the leaders in implementing climate adaptation strategies (Boswell et al., 2012; Stults & Woodruff, 2017). Focusing on local issues may also be effective for achieving political support for interventions. Political support is both a public issue and affects personal attitudes, thus cutting across both contextual and psychosocial antecedents of behavior. In the U.S. in particular, public attitudes toward climate change are closely related to political identity and affiliation (Leiserowitz et al., 2020). Some programs focus on local climate change impacts without directly linking them to climate change, such as the Moore, OK, building codes (Ripberger et al., 2018), which focus on wind hazards and tornadoes but make no direct link between these hazards and climate change. Other programs use local impacts as an entry point to discussion of broader climate change, such as the CLEAR program (Catalyst Miami, 2017), which starts with local issues such as sea level rise and contextualizes them in broader climate and social issues. They then return to local issues when discussing potential actions. Focusing on local issues may also lead to greater agreement on overall adaptation goals (e.g., reducing negative health impacts of heat in one's city) among varying organizations, which is a critically important component of successful collaborations (Kania & Kramer, 2011; Wondolleck & Yaffee, 2000).

Limitations and caveats

One limitation of the work presented here is that it cannot provide guidance on which antecedents or interventions might be most effective in supporting desired adaptation behaviors and outcomes. Van Valkengoed & Steg's (2019a) meta-analysis identified key psychosocial antecedents of adaptation behaviors, but no similar work has been conducted regarding contextual antecedents or interventions.

Another limitation of this article is that it focuses on designing and implementing formal interventions rather than on drivers of grassroots behavior (Seyfang & Smith, 2007). While the interventions described in this article can be participatory, they are nonetheless top-down in the sense that practitioners are seeking to change the behavior of other individuals or groups. Behavior change can also occur bottom-up, as individuals or groups might choose to make a change without external support (Butler et al., 2015). Research on sustainable behaviors, for example, has included studies of how individuals might choose to make long-term lifestyle changes (e.g., Litfin, 2013) or be empowered to participate in civic engagement (e.g., Krasny & Tidball, 2012). To date, grassroots-driven adaptation behaviors have not received significant attention from scholars. Research on sustainable behaviors may provide a promising starting point for such work.

The third limitation of this article is that it draws on research and practices largely conducted and implemented in the Global North and particularly, the United States. The adaptation behaviors relevant to individuals in the Global South may differ (Chapter 2). Nonetheless, key aspects of our model and typology may apply internationally. For example, climate change impacts, contextual and psychosocial antecedents are likely to predict adaptation behaviors in most nations, although the specific climate change impacts and adaptation behavior antecedents may be quite different. Moreover, community-research partnerships (Butler et al., 2015), institutional structure change (Ayers & Forsyth, 2009), and information provision (Lee & Davis, 2019) have been successful in supporting adaptation behaviors in varying national contexts.

Conclusion

Climate change already is and will continue to influence the day-to-day lives of individuals

around the world. Personal and household adaptation behaviors are not the only method to respond to climate change impacts, but there are aspects of adaptation that these behaviors are uniquely suited to address. For example, individuals are the most effective actors for protecting their own mental health (Reser & Swim, 2011). and personal property (Grothmann & Patt, 2005). and can bring about community and societal change by reaching out and collaborating with others (Thaker et al., 2016). Even when individuals have the best of intentions, however, they often cannot enact adaptation behaviors on their own. Thus, there is a need for support. To ensure this support is effective, it is important to draw on a comprehensive understanding of what predicts adaptation behaviors. The purpose of our synthesized model and typology of interventions is to facilitate this process by contributing to advancing and bridging both research and practice. Because there is no single behavior or intervention that will meet all adaptation needs, we encourage a flexible approach to supporting personal and household actions that will achieve desired adaptation outcomes.

CHAPTER 4

Implementing Climate Change Adaptation Behavior Change Programs: Insights from Practitioners in the United States[3]

As climate change increasingly affects individuals' day-to-day lives, it is critically important to understand how to help individuals adapt. While the literature on personal and household adaptation behavior is growing, little is known about how adaptation behaviors are supported by practitioners. To address this gap, we conducted 29 semi-structured interviews with professionals who have implemented, planned, funded, and/or researched interventions to support individuals' adaptation behaviors in the United States. A synthesized model of adaptation behavior guided questions about the behaviors that practitioners supported and the outcomes they expected these to contribute to, as well as about the contextual and psychosocial factors they considered relevant to behavior and the interventions they implemented. Practitioners sought to support multiple adaptation behaviors, especially civic engagement, household protection, and learning, primarily to benefit communities. They described contextual antecedents more readily than psychosocial antecedents of adaptation behaviors, yet many relied on information provision interventions. Moreover, some were reluctant to acknowledge behavior as an explicit program goal, while others focused on behavior as a means for individuals and communities to gain control of adaptation in their community. Finally, practitioners were more likely to emphasize the importance of trust and mistrust, and of addressing social inequalities, than adaptation behavior

[3] A version of this chapter is currently in preparation for submission to *Climatic Change*.

research to date has done. There is a need for improved communication among researchers and practitioners to better support urgently needed adaptation behaviors.

Introduction

Personal and household climate change adaptation behavior has become a topic of increasing scholarly interest. Research on personal and household adaptation behavior, which we will henceforth refer to *adaptation behavior*, suggests that these behaviors are predicted by climate change impacts, contextual factors, and psychosocial antecedents, and result in outcomes and feedbacks, and has resulted in a proposed typology suggesting how different interventions may align with this model (Chapter 3). Interventions are important in the context of adaptation because they can provide resources or activate motivations for individuals to engage in behaviors that provide personal, social, and/or environmental benefits in the face of climate change impacts and that they might not enact on their own (Chapter 2).

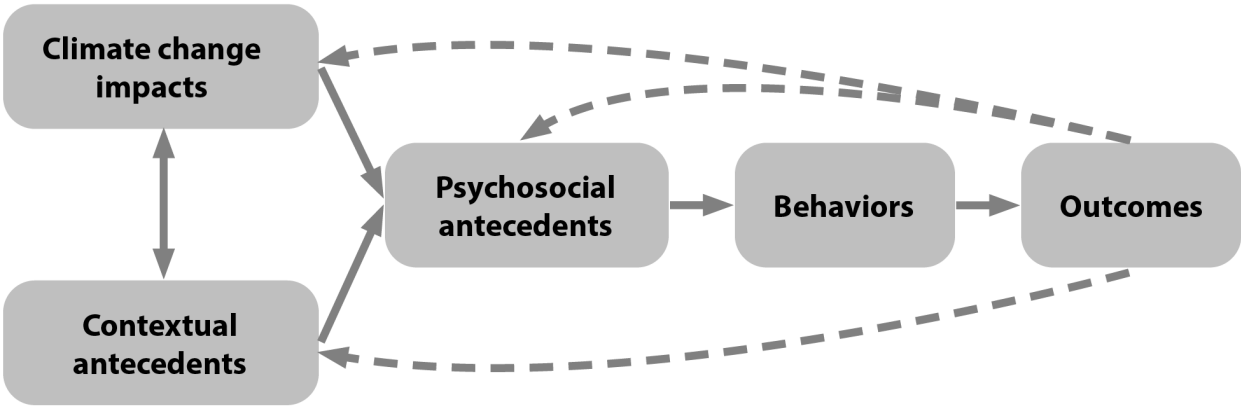


Figure 4-1. Conceptual illustration of synthesized theoretical model (modified from Chapter 3)

It is important to learn if and how research on adaptation behavior aligns with existing practice. Practitioners' needs, concerns, and thought processes differ from those of researchers, and understanding the unique needs of practitioners can help researchers develop more relevant and impactful adaptation research (Mach et al., 2020; Moss et al., 2013). Moreover, research on behavior in the areas of environmental conservation and climate change mitigation have

produced a robust area of literature illustrating how behavior change theories can inform practice (e.g., Rare and The Behavioral Insights Team, 2019; Schultz, 2014; M. J. Stern, 2018). Comparatively, research on adaptation behavior interventions is much smaller and in an earlier stage (Chapter 3; van Valkengoed & Steg, 2019b). Nonetheless, practitioners are already carrying out practices related to adaptation behavior (Chapter 3), but it is not clear whether existing adaptation behavior research is informing their design.

Box 4-1. Definitions of key terms

Personal and household adaptation behavior: Actions affecting oneself or one's household that may be reactive or proactive, taken alone or with others and for the purpose of protecting or benefitting individuals engaging in these actions, others, or environmental quality either in the short- or long-term

Climate change impacts: Hazards associated with climate change that affect individuals' lives, including short-term events such as fires and long-term changes such as sea-level rise

Contextual antecedents: Factors external to an individuals' decision-making and affect their ability to carry out behaviors, including personal factors such as physical health and socioecological factors such as recent hazard events

Psychosocial antecedents: Internal and interpersonal factors that affect individuals' intentions to carry out behaviors, such as risk perception and trust

Outcomes: Short- and long-term desired results of behavior, ranging from improvements to personal health to broader societal change

Interventions: Activities to change either opportunities or motivations so that individuals engage in behaviors they might not enact otherwise

We conducted qualitative research with practitioners in the U.S. to understand their practices related to personal and household adaptation behavior. A similar study has been conducted to understand practitioners' perspectives on urban resilience (Meerow & Stults, 2016). We focused on urban settings because most of the world's population lives in cities (UN DESA, 2018), and the types of behaviors that are relevant in these settings are different from those in rural settings (e.g., farming practices; Feola et al., 2015). Our research focused on the U.S. in

part because relatively little research on adaptation behavior has been done in the U.S. compared with other countries with similar levels of wealth (Chapter 2), yet practitioners in the U.S. are already carrying out adaptation behavior interventions (Chapter 3). Adaptation behavior has been mentioned in major reports such as the 4th National Climate Assessment (USGCRP, 2018) and a recent report by the U.S. Agency for International Development (Lee & Davis, 2019). This inclusion suggests that there is interest in this topic in the U.S. but little exploration of ways to support it.

Our study sought to answer five research questions:

1. What behaviors do adaptation practitioners in the U.S. support?
2. What impacts, contextual antecedents, and psychosocial antecedents do practitioners think predict these behaviors?
3. What outcomes do they think will result from these behaviors?
4. What adaptation behavior interventions are practitioners carrying out?
5. What other insights can scholars learn from practitioners' work?

Methods

Sample Design and Recruitment

This study was based on semi-structured interviews with 29 practitioners across the U.S. in summer and fall 2019. We conducted interviews because adaptation behavior is an emerging area, and it was uncertain before our data collection how interviewees might describe their practices. Thus, interviews were a better fit for our exploratory analysis and allowed us greater flexibility to capture practitioners' language and perspectives (Maxwell, 2013; Young et al., 2018). Interviewees worked at multiple types of organizations: Twelve interviewees worked for local government, either as a sustainability officer or in a related department in cities that did not

have a dedicated sustainability office; seven at private or non-governmental organizations; five at U.S. federal agencies; and five at education and research institutions.[4] We included multiple types of practitioners to capture the variety of ways that practitioners might incorporate behavior in their activities. Interviewees' work focused on different geographic scales: 14 worked at the local level (i.e., within one city or county), four at the state, two at the regional (i.e., multi-state), and nine at the national level. Interviewees represented locations from 16 states plus the District of Columbia, and at least one interviewee was from each major region of the United States. No more than three interviewees were from any one state, except for Washington DC (n=6). Of the twelve respondents who worked in local government,[5] four were in governments that had adopted both climate action plans (CAPs; Boswell et al., 2012) and separate formal climate adaptation plans; three in governments that had adopted CAPs that included adaptation policies (e.g., floodplain management changes) but not separate adaptation plans; two were in governments that had adopted sustainability plans but not separate CAPs; two were in governments that had adopted sustainability policies (e.g., setting renewable energy goals) without having a master sustainability plan; and one was in a government that had not adopted any formal sustainability policies.

[4] Some interviewed practitioners were at research institutions that were affiliated with a university, including a RISA and a NOAA Sea Grant office (n=2), but some were not affiliated with a university (n=3). The two practitioners from universities did not include tenure-track faculty, and interviews focused on their public outreach and engagement practices rather than research they conducted on climate change impacts. We refer to them as practitioners for the sake of simplicity, but we acknowledge that the researcher-practitioner boundary blurs somewhat in these cases.

[5] No practitioners were identified who conducted work relevant to adaptation behavior in a state government. Of the four practitioners who worked at the state level, one worked at a nonprofit organization and the other three worked at education and research institutes.

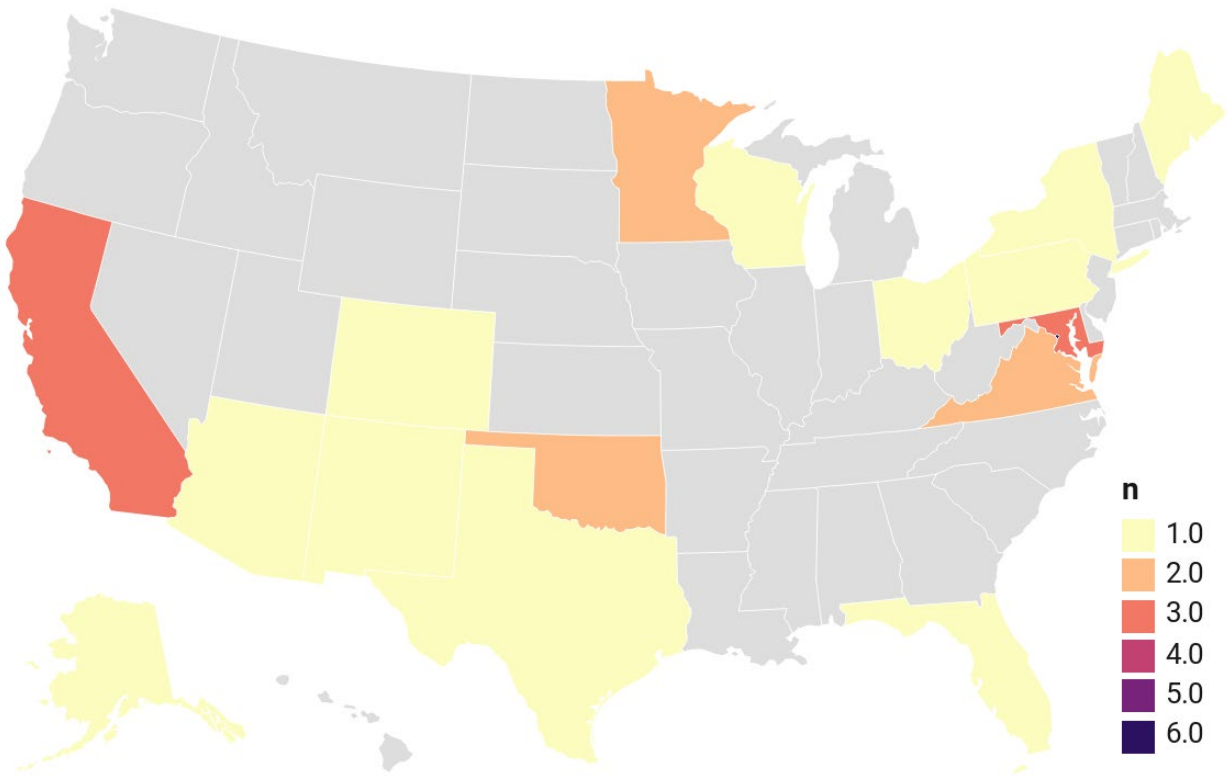


Figure 4-2. Locations of interviewees by state, plus District of Columbia (n=number of interviewees per state)

Our study used a mix of key informant and snowball sampling (Young et al., 2018). There is no centralized resource for practitioners conducting adaptation behavior activities, so the eligible population of practitioners is unknown. This sample was not designed to be statistically representative of adaptation practitioners in the U.S., but to capture the breadth of types of adaptation behavior work that practitioners may engage in. Interviewees were initially recruited from participants at the United States' 4th National Adaptation Forum (NAF), a national conference for adaptation practitioners with 1,035 attendees. The lead author contacted presenters who appeared to conduct interventions to support personal and household adaptation behaviors, including community or public engagement, education, and awareness-raising efforts. The lead author then asked the NAF interviewees to identify additional potential practitioners, whom the lead author subsequently contacted. Twenty total interviewees were recruited from

NAF. Five interviewees were identified through referrals from these interviewees, while one interviewee was identified through a referral from another professional who was contacted but not interviewed. The author also identified three interviewees from professional networks including the Climate Action Knowledge Exchange (CAKE) and the Climate Psychiatry Alliance to fill in gaps in geography or target adaptation behaviors. All interviewees confirmed they were currently implementing (n=22), planning (n=2), funding (n=3), or researching (n=2) relevant interventions. Potential interviewees who were not conducting any relevant activities were excluded from the sample. We recruited participants for saturation (Saunders et al., 2018) on region and the types of behaviors and climate change impacts named, so that all major regions of the U.S., and all types of behaviors and impacts identified from the literature (Chapter 2), would be represented in the sample.

The lead author did not collect demographic data from interviewees, but all interviewees were adults who worked on environmental issues. Interviewees reported working in the adaptation field between one to 30 years, with a mean of 7.9 years. All interviewees had at least an undergraduate degree, and many had graduate degrees. Most respondents appeared to be White women, but respondents included several White men and a few women of color. The lead author is also a White woman with a graduate degree and professional environmental background.

Data Collection and Analysis

The interview guide was developed by the lead author to explore what behaviors practitioners sought to support; what interventions they implemented (or planned); what climate change impacts, contextual and psychosocial factors they considered relevant; and what their desired outcomes were. The lead author reviewed the interview guide with a co-author and pilot tested it

to adjust question wording before the interviews. Question wording was adjusted for interviewees who conducted work with single communities versus practitioners who provided funding for or conducted research on multiple programs.

Interviews were conducted in person or by phone. Interviews ranged from 19 to 56 minutes, and the mean length was 37 minutes. The author conducted 12 in-person interviews with NAF conference participants, and all others were conducted by phone. Interviewees received printed information about the study, including its purpose and researcher contact information in advance. Six interviewees provided additional documentation such as informational handouts and evaluation results. All interviews were recorded with the interviewee's verbal consent, and responses are reported anonymously. Quotations from interviews have been lightly edited for clarity.

Seven interviews were transcribed by the lead author using ExpressScribe transcription software. The interviewer then switched to an automated transcription software (Rev) to produce first drafts of the remaining transcripts. Those automated transcripts were reviewed in detail by the interviewer and one co-author along with the original audio and interviewer notes to ensure the final transcripts were accurate. The authors found no differences in overall accuracy of transcripts between the manually produced transcripts and the transcripts developed by automatic software after detailed review.

The lead author developed an initial codebook (Young et al., 2018) building on existing adaptation behavior research. The coding categories, and the specific codes for contextual antecedents and intervention types, were based on the authors' model synthesis and intervention typology paper (Chapter 3). The coding for behaviors, climate change impacts, and behavioral outcomes were based on codes identified from a systematic literature review (Chapter 2).

Finally, the coding for psychosocial antecedents were based on motivators identified by van Valkengoed & Steg's (2019a) meta-analysis. The complete codebook, including sources for each code, are provided in Appendix 2.

The lead author and one co-author coded all interviews and supporting documentation using NVivo and added new codes based on emergent themes, while also generating memos throughout the process (Maxwell, 2013). Codes were reviewed regularly to ensure inter-rater reliability of coding (Campbell et al., 2013). Both coders agreed on the final coding for each interview. Interviewees who provided supporting documents had both their interview and supporting documents combined into one interviewee case in NVivo, so that coding of documents and interviews from the same person was not double counted.

Results

What behaviors are practitioners supporting?

We analyzed interviews to assess if interviewees sought to support eight types of adaptation behaviors identified in the literature: civic engagement, consumption changes, coping, household protection, learning, lifestyle changes, migration, and self-protection (Chapter 2). Of these behaviors, practitioners mentioned learning, civic engagement, and household protection most often, and coping behaviors least often (Table 4-1).

Table 4-1. List of personal and household adaptation behaviors identified by practitioners, including by geographic scale of their work

Behavior type	**All practitioners (N=29)**	**Local (n=14)**	**State (n=4)**	**Regional (n=2)**	**National (n=9)**
Civic engagement	25	13	4	1	7
Consumption	19	11	4	0	4
Coping	3	2	0	0	1
Household protection	21	10	4	2	5
Learning	23	12	4	1	6
Lifestyle change	9	7	1	0	1
Migration	13	3	3	2	5
Self-protection	13	7	4	1	2
Other behaviors*	5	2	0	0	3

* Other behaviors included getting jobs in related fields (*n*=1), using public transit in winter (*n*=1), choosing not to migrate (*n*=2), re-entering a home after a buyout (*maladaptive*; *n*=1), mowing or using flood buyout zone land (*maladaptive*; *n*=1).

Practitioners generally described civic engagement as the most important behavior to support. Civic engagement can either include non-political actions, such as talking to neighbors or participating in a volunteer event, or political actions, such as advocacy and policy support. Many emphasized engaging in political action. For example, one communication specialist at a federal agency said that engagement on local adaptation policy was one of their outreach goals:

> *"My expectation is they come out asking questions, whether that be about their personalized risk, [or] talking to their local officials, saying 'What does this mean for my community, my neighborhood, my kid's school?'"*

The adaptation behaviors that were mentioned next most frequently were learning and household protection. In terms of learning practitioners particularly wanted individuals to learn about their personal and community climate change risks, and what they could do in case of hazardous events, including what resources are available to them. Several also mentioned that some individuals might learn how to take a leadership role in their community. For example, one city sustainability officer described how they hoped learning about resilience would lead to other behaviors:

> *"Empowering people means to educate them, give them the training to be part of the political discussion, and then to build the confidence that they can go out and be their own leaders for their smaller community."*

Household protection actions were generally described in terms of hazard mitigation and protection from discrete extreme events. While most practitioners named household protection actions such as having household emergency kits, several practitioners referred to these kinds of actions as "*basic,*" suggesting that they were beginning steps for adaptation rather than final desired behaviors. For example, one city sustainability officer said:

> *"There's some basic stuff, like making sure you have water in your car and making sure that you're equipped for a power outage."*

Self-protection and coping behaviors were mentioned least often. In fact, only three practitioners mentioned coping behaviors, and of those three, two were mental health professionals.

We found that practitioners varied somewhat on what behaviors they named depending on the geographic scale at which they worked. Practitioners who worked at the local level were much less likely to discuss migration behaviors than practitioners at the state, regional, or national levels. Local practitioners were also more likely to mention self-protection and lifestyle change compared with practitioners at other levels.

What relevant climate change impacts, contextual antecedents, and psychosocial antecedents did practitioners describe?

Impacts

Practitioners named many possible relevant impacts of climate change, with short-term impacts (i.e., flooding, extreme weather, heat waves, fires) mentioned more frequently than long-term events (e.g., sea level rise; Table 4-2). Notably, many practitioners named combinations of specific impacts, such as drought and fire risk, or flooding and heat waves. Most practitioners

(*n*=20, 70%) described secondary impacts of climate change as well, such as infrastructure damage or health concerns. For example, one city sustainability officer described how flooding affected their community:

> *"We've had a lot of events, a handful of events, that have been sort of two-fold, like flooding would [happen] two counties over, [it] overwhelms our water system and we have a water quality notice for two weeks."*

Table 4-2. Climate change impacts identified by practitioners

Impact type	**Mentions by practitioners (N=29)**
Climate change impacts (general)	3
Changes to hydrological cycles and water supply	3
Drought	10
Extreme weather events	19
Fire	8
Flooding	22
Heat waves	14
Infectious disease vectors	8
Precipitation change	8
Sea level rise	8
Temperature and seasonality changes	12
Other impacts*	8

* Other impacts include fisheries management changes (*n*=1), winds and tornadoes (*n*=2), ocean acidification (*n*=1), ocean warming (*n*=1), species migration (*n*=1), increased ground level ozone formation (*n*=1), and changes to land subsistence (*n*=1).

Most practitioners discussed addressing climate change impacts on both short- and long-term time scales. Even practitioners who avoided using language of climate change directly would discuss responding to long-term hazards. For example, one management specialist at a consulting firm stated:

> *"We're starting to enter the resilience conversation. But, again, not really talking about climate change. So we do have a lot of resources that talk about hazard mitigation and then looking at the bigger picture of long-term resilience."*

Contextual antecedents

Practitioners named many personal and sociological contextual antecedents relevant to their work (Table 4-3). The factors named most frequently were socioeconomic status, location

relative to existing environmental risks (such as being a flood or fire hazard zone), economic inequality, and existing infrastructure. When asked, most practitioners also named a specific natural hazard event that occurred in their community that appeared related to climate change. Furthermore, many practitioners emphasized that it was critically important for their outreach to be sensitive of these contexts. One NGO's program director said that understanding context was key to understanding what kinds of community actions were needed:

> *"How are we thinking about communities and community members and their ability to adapt and thrive amidst these changing conditions? In all these different conditions. I mean their political system conditions, or climate conditions, all of the conditions."*

Practitioners also emphasized addressing inequality and vulnerability, and most (more than 80%) mentioned economic, racial, or other social inequalities as relevant to their work and communities. An NGO's senior program officer stated that economic inequality was a major barrier to public engagement on adaptation:

> *"The more and more I've worked in this space, I recognize how the wealth inequities and people living in poverty or people not making a living wage is so critical to what we are having to change, and encouraging the change that we need to see from people. They need to have the capacity to actually do that."*

An emergent contextual factor was spoken language. Namely, several practitioners (about 20%) said that they worked with communities in which residents spoke multiple languages other than English, some of whom did not speak English at all. One city sustainability officer described how these language differences necessitated different approaches:

> *"With our school districts over 90 first languages are spoken in [CITY] alone. So when there is an emergency… there were notices put out that said 'boil your water,' well, we've got to put those out in many different languages."*

Table 4-3. List of contextual antecedents of personal and household adaptation behaviors identified by practitioners

Contextual antecedent type	**Mentions by practitioners (N=29)**
Personal factors	
Age	15
Mental health	3
Physical capabilities	4
Physical health	8
Socioeconomic status (income, home ownership)	22
Socioecological factors	
Community resilience (shared knowledge, social bonds)	17
Culture	12
*Differences in spoken language**	6
Economic inequality	21
Existing demographic changes	7
Existing infrastructure	21
Existing policy	18
Historical natural hazard events**	20
Historical non-natural hazard events	4
Location and existing environmental risks	21
Racial inequality	7
Social inequality (general)	15

* Italics denote emergent codes.
** Prompted response.

Psychosocial antecedents

Compared with contextual antecedents, practitioners put relatively less emphasis on psychosocial antecedents of adaptation behaviors. All practitioners were able to name at least one psychosocial antecedent, but few practitioners described intentionally integrating them into their program design. In one exchange, a federal agency funder said so explicitly:

> *Interviewer: "Are there other longer-term psychological dimensions, identity or values, things like [that], is that something you incorporate into your design?"*
>
> *Practitioner: "We aren't specifying that."*

Those who mentioned psychosocial antecedents frequently used different terminology than adaptation scholars. For example, practitioners mentioned descriptive norms and self-efficacy relatively often, though they generally used "*agency*" and "*empowerment*" to describe

self-efficacy and "*peer pressure*" to describe descriptive norms. Practitioners also named several psychosocial factors, including general pro-environmental concern and social connections, which was not included in the original codebook based on van Valkengoed & Steg's (2019a) meta-analysis.

Table 4-4. Psychosocial antecedents of personal and household behaviors identified by practitioners

Psychosocial antecedent type	**Mentions by practitioners (N=29)**
Climate change belief	9
Descriptive norms	10
Experience**	21
Injunctive norms	1
Knowledge	18
Outcome efficacy	2
Negative affect	4
Place attachment	10
Pro-environmental attitudes and climate change concern[§]	11
Responsibility	3
Risk perception	13
Self-efficacy	14
Skills	4
Social connections	6
Stress	5
Trust in implemented measures	3
Trust in government	11
Trust in other people	2
Other motivators [ǂ]	5

** Prompted response

[§] Italics indicate emergent codes not identified in van Valkengoed & Steg (2019a) meta-analysis

[ǂ] Other motivators include extrinsic motivations (n=1), information processing difficulties (n=1), intrinsic satisfactions including gratification from participation and knowledge gains (n=2), self-improvement (n=1), guilt (n=1)

Notably, many practitioners put a strong emphasis on trust and mistrust, especially in government. While experience, knowledge, and self-efficacy were mentioned more frequently than trust, practitioners who mentioned trust emphasized that it was a key factor for their efforts successfully engaging participants. Even in those cases, however, trust was generally not described as a being a component of program design or goal-setting. For example, a city

sustainability officer explained how mistrust prevented their city's program from reaching its goals:

> *"So, about a year ago … we decided to have these meetings every two weeks, 50% community members, 50% city staff from multiple departments. … The idea was that we would come together and figure out some kind of project. … [It] didn't work out … [We thought] if we just had stories from people, they'd tell us about floods. But then, there was a lot of distrust of the government, of 'What are you going to do with these stories?' And 'Who's going to own them?' And 'Who's going to interpret them?' And 'What are you going to do with them?' And 'Is it going to change anything?' So that went by the wayside."*

Only a few practitioners described deliberately incorporating psychosocial antecedents into their program design. For example, one communications specialist at a federal agency described how they worked with behavioral researchers to design communications that elicit emotional responses to climate hazards, which they then build on to connect to behaviors:

> *"We recognize that data is no longer enough in terms of how we communicate risk to people, and needs to be built a lot on that emotional, visceral reaction. … It's moving away from the specific scientific data and recognizing the different times and things people care about, and not try to scare people, not try to make them sad, but connect it to things that they have emotional connection to, the risk resonates a lot more with them. And then we try and connect them with resources to make it actionable for them."*

This strategy represents a change in the agency's approach, as indicated by the interviewee's statement that data is "*no longer enough*" and they are "*moving away*" from using it.

What are desired outcomes?

Practitioners mentioned many possible desired outcomes from their activities, particularly ones that provided community benefits such including short-term community improvements, policy change, and broader social change (Table 4-5).

Table 4-5. Personal and household adaptation behavior outcomes identified by practitioners

Outcome type	**Mentions by practitioners (N=29)**
Community outcomes	24
Community benefits (short-term)	22
Policy change	11
Social change (long-term)	8
Environmental outcomes	14
Financial savings	13
Knowledge or awareness change	6
Mental health	17
Physical health	13
Safety	13
Other outcomes†	1

† "Other" outcomes mentioned by practitioners include reduced strain on the power grid (n=1).

Some practitioners also named outcomes that their activities did not achieve or resulted in undesirable outcomes. This latter issue was discussed in an interview with a research consultant who works specifically on home buyout programs that purchase flooded homes to encourage migration. They found that many buyout participants moved into similarly flood-prone homes:

> *"Basically the neighborhoods that were bought out were working class neighborhoods, so I can write you a check for the full value of that home in the working class neighborhood, but that's not enough money to buy a similar home in a safer neighborhood. So you have people moving but not necessarily moving to a safer place, or having some considerable losses down the road."*

Mental health outcomes were an important outcome mentioned by several practitioners. Although most practitioners acknowledged mental health as an important outcome, many only did so when prompted. For example, one federal agency funder expressed the importance of addressing mental health outcomes although it is not one their organization prioritizes:

> *"We haven't historically looked at a lot of mental health kinds of outcomes. I can see that that would be something we would want to look at, but we tend to look at more sort of traditional education gains as our outcomes."*

Practitioner interviews included an emergent category of knowledge and awareness change as a desired program outcome, which were not identified from adaptation scholarship.

These practitioners said they wanted participants to gain a better understanding of climate change programs, but not much else.

What types of interventions are being carried out?

We also asked practitioners to describe interventions that they were carrying out, planning, funding, or researching. These interventions fall into two broad types: structural and informational (Steg & Vlek, 2009). Structural interventions aim to change opportunities for behavior, while informational interventions aim to change motivations for behavior (Steg & Vlek, 2009), and educational programming and financial support have elements of both (Chapter 3). The two types of interventions that practitioners named most often were community-building activities and information provision (i.e., informational interventions), followed by infrastructure changes (i.e., a structural intervention) and cross-cutting educational programs (Table 4-6). Information provision could include traditional activities such as informational handouts and lectures or new activities such as virtual reality simulations of a climate hazard event. Community-building activities were intended to facilitate connections among community members and could include formal or informal gatherings. Infrastructure changes included both physical infrastructure (e.g., changes to roads or tree planting) and non-physical infrastructure (e.g., mapping hazards). Practitioners described physical infrastructure changes more often than non-physical ones.

While many practitioners described making physical infrastructure changes linked to behavior, such as working with residents on tree planting, few explicitly linked those interventions to desired behavior changes. One city sustainability officer, for example, described working toward changes to housing that were implicitly linked to behavior but not marketed that way to residents:

"The whole city needs to be investing in desert-adapted green infrastructure. … You need the investing in green infrastructure in your HOA [homeowners association] or with the apartment that you're at, or in your home. You need to be looking for opportunities for increased shade and for cool materials. So there is a whole way to sort of sell this to individual property owners. We haven't done that yet."

Table 4-6. List of interventions identified by practitioners

Intervention type	**Mentions by practitioners (N=29)**
Structural Interventions	
Product or technology availability	8
Infrastructure change	22
Non-physical infrastructure	8
Physical infrastructure	19
Institutional structure change	8
Policy change	11
Cross-Cutting Interventions (both structural and informational)	
Educational programming	18
Financial support	12
Informational interventions	
Community building activities	25
Community research partnerships	12
Psychological support	4
Information provision	25

Additionally, all practitioners described engaging in multiple interventions. Some practitioners also described programs that participants could engage in over time. For example, one city sustainability officer described how some participants in neighborhood climate workshops (educational programming and community-building activities) received additional training to become local climate advocates (educational programming and financial support):

"As part of our last plan we had 12 neighborhood [climate] workshops in 12 different neighborhoods. … Each of those neighborhoods had 4 climate ambassadors. These are residents that got trained, got paid to kind of be the local advocate on climate, connect resources to people."

What other important insights can scholars learn from U.S. practitioners' work on adaptation behaviors?

Ambivalence about behavior and its role in adaptation

While all interviewees named specific personal and household behaviors relevant to adaptation, very few described these as "adaptation behaviors" specifically. Most interviews used related language such as "*resilience*," "*hazard mitigation*," "*climate preparedness*," or more general language of "*addressing climate change*" instead. Similarly, behavior was discussed in terms of "*action*" or "*what individuals might do*" more often than being referred to as *behavior* or *behavior change* specifically. This variation in language allowed practitioners many avenues to talk about how they integrated behavior into their practices. Nonetheless, some practitioners were hesitant to acknowledge that adaptation behavior is relevant to their work, even when their work involved direct engagement with individuals from the public. Their responses revealed several possible explanations for this reluctance.

One reason was a reluctance to attempt to change other individuals' behaviors. In a few cases, respondents would say that they were unsure what behaviors they wanted their programs to change, and then, on further prompting from the interviewer, describe multiple behaviors that they thought were relevant. For example, in response to the interviewer's question about adaptation behaviors the practitioner would like individuals to participate in, one city sustainability officer said:

> *"That's hard to say cause … it's been ingrained in my head that I don't want to impose actions on people, like, 'Your life would be better if you do what I tell you to do.'"*

Furthermore, an NGO's program officer, when asked what behaviors they expected individuals to engage in, began with their reluctance to describe behavior change as an explicit goal:

"Um, expect, I don't expect much, ultimately. I'd hope for a few things."

Upon further prompting, both interviewees described specific behaviors that they hoped would occur, including learning and civic engagement. The latter interviewee gave a lengthy response describing learning, civic engagement, and household protection over both short- and long-term time scales:

> *"It's recognizing that climate change will lead to some disturbances and we will see more frequent and severe natural disasters and extreme weather events, so that they're prepared and taking early action to ensure that they're prepared … And then I think another part is social cohesion, and community cohesion is so critical. … So I think leveraging the events that we host to provide that opportunity for folks to connect is really important. They also get a better sense of the community-based organizations that they can get involved with and they can go to for additional support. … For the longer term, more chronic impacts that we'll see rather than just the immediate natural disasters … making sure that they're building awareness around climate change and where they can get more information, and things like that."*

A second reason for this apparent was reluctance to discuss behavior was defining *behavior* as consumption and conservation-related behaviors, which were subsequently dismissed as insufficient. In fact, while most practitioners mentioned consumption behaviors (Table 4-1), when they did so, they mostly also shared that those behaviors were inadequate. One federal contractor immediately dismissed the idea of behavior as relevant to adapting to climate change. When asked what individuals could do to address climate impacts in their lives, the contractor said:

"Heh. Very little."

When probed, the contractor went on to describe only conservation behaviors:

> *"Not very little. I should rephrase that a little bit. So any individual's impact is very little by definition. And I'm old, so I was there when Earth Day was started and we were trying to push recycling and just having a light footprint on the planet.… I hear people say, 'Yeah, I'm cutting my carbon footprint.' That's a conscious individual choice that will help. Personally, I think a lot of that is just feel good, it can't hurt … But the impact of that, I think is small."*

As suggested by the above, there are likely to be practitioners who are not conceptualizing individual and household behavior as related to climate change adaptation. The same NGO program officer who had initially been reluctant to discuss adaptation behavior change described this challenge:

> *"Behavior change is really, really challenging. Even on the mitigation side, right? Where there are very clear-cut options that people can take. … I think with adaptation, it's a lot harder and a lot easier in a lot of ways. I think it's a lot harder because there isn't necessarily a definitive list of steps and actions that people need to take … and how that connects back to how much reduction you'll see in terms of risk. But on the other hand, I think adaptation is broad enough that there are so many adaptation measures that can be connected back to other priorities that that individual or that community might have to start with."*

This latter quote illustrates that some practitioners see adaptation behavior as distinct from mitigation behavior, and that some practitioners might not.

A third reason for reluctance to discuss behavior was that several practitioners described systems changes was more important than changes in adaptation behaviors. For example, one federal agency funder argued that only system change would bring about personal behavior change, and as a result behavior change was not important:

> *"It's very hard as an individual to do a lot, because the systems they are operating in are what is going to enable or frustrate those solutions. … I think that the individuals can do some actions, but it's really looking at system responses – an individual can call for a system to change, but operating individually is not really going to change things in the end."*

Others, however, argued that individuals could bring about system changes, when working with others collectively. In doing so, however, they would not clearly describe collective action as a type of behavior. Instead, they would appear to put behavior and collective action in competition with each other. For example, one mental health practitioner discussed how they integrate thinking about collective action into their practice:

> *"What is important is joining with others to take action because things that one does individually can feel like a drop in the bucket. … But clearly none of us*

> *created this on our own and we're not going to be able to make big differences individually either. It involves joining with other people and understanding the power and creativity in collective agency."*

In both instances, practitioners described behavior change interacting with system change, either as an outcome (in the former case) or predecessor (in the latter), but in their wording stated that individual behavior was unimportant. This tension suggests that behavior is a part of their thinking, but they did not want to use the language of behavior change to describe it.

Ceding control to provide support for behavior

In contrast to the above, many practitioners were readily able to discuss the role of behavior in adaptation. For these practitioners, fostering adaptation behavior was not about prescribing specific behaviors but empowering individuals to create options for themselves. By focusing on ceding control and providing support, these practitioners suggest that individuals are better able to protect themselves from negative climate change impacts and advance improvements for themselves and their communities. One mental health practitioner described this as the goal of their practice:

> *"The intention for me when I'm working with families, individuals, at the end of the day is for me to recognize their agency and how I can promote that. So I'm not the expert, I am the resource."*

A communications specialist at a federal agency described their goals similarly:

> *"My job isn't to force everybody to act, it's to get them to a place where they can make the decision that's right for them."*

Practitioners who worked with city governments described this approach as requiring change in the role of local government. An NGO program director who works with local governments described the shift in structural terms and particularly in terms of promoting equitable distribution of power:

> *"The real piece in this that I don't want to get lost is that it's really about shifting power. … The power is shifting from government into the hands of individuals*

> *who can identify what sort of programming they need and what sort of resources they need to meet their everyday needs and start to clear stressors. And when we focus more of that it, enhances the adaptive capacity to deal with the shock."*

These practitioners noted that city governments have historically employed a command-and-control approach and that shifting their role can be challenging. One city sustainability officer said that this shift was difficult but necessary:

> *"What local governments can have a hard time doing sometimes is relinquishing control. And having it be more organic, which is where our summit started and these working groups. All that came out of this commitment to this more of an organic process. We're there more to support others in their work than leading it per se."*

Not making this shift may result in negative consequences for individuals that programs are meant to serve. A research consultant who works on buyout programs shared that not giving control to residents can cause harm rather than benefits:

> *"The buyout programs that work better are buyout programs that really give space for resident involvement in the process. So on paper buyouts are voluntary, but in practice what people say is 'We have no choice. Of course we have to take it, and if we don't take it they're going to take our house.' ... So that experience of being forced out of your home is pretty traumatic."*

Notably, this theme emerged from practitioners working across numerous sectors and contexts, including federal agencies, local government, non-government organizations and private firms, working from the national to the local level. In the case of government practitioners especially, this approach required thinking differently about their role as an intervener, by providing support rather than seeking compliance.

Framing strategies emphasize personal experience

Although practitioners described relatively few psychosocial antecedents when discussing their practices, most (n=25, 86%) said that framing, i.e., the way that information is presented and what information is emphasized (Tversky & Kahneman, 1981), plays an especially important role in their activities. Although framing generally refers to emphasizing positive or negative

information (Tversky & Kahneman, 1981), in climate change communication, one of the major framing challenges is framing distant versus immediate risks (Milfont & Gouveia, 2006; Weber, 2006). Practitioners discussed three framing strategies, all of which linked community members' personal experience to immediate climate change risks, to engage them with climate change adaptation and potential behaviors.

The first framing strategy was directly connecting individuals' experiences to climate change, so that individuals could understand how climate change was relevant to them. One city sustainability officer described how they reframed climate impacts to emphasize the day-to-day impacts that affect people:

> *"We always start off with what are your assets, then what are your concerns, and then we tie those assets back to climate as opposed to the other way around."*

The second was de-emphasizing climate change to focus on specific actions that address climate change adaptation needs and provide other benefits. A city sustainability officer described needing to reframe outreach to focus on direct concerns rather than wider climate change-related issues:

> *"In a couple of the workshops we did do a little bit on land use and how that relates to changing climate. But really regardless of how we start the conversation, it usually comes back to preparedness. I think it's easier for community members to grasp and feel like they have some agency around. Land use tends to be more abstract and get to a point of, 'This property at my corner is flooding, but what do I have any control about?'"*

This framing strategy may be particularly important for reaching communities that have been historically marginalized, who are more likely to face harsher climate change impacts while also continuing to experience existing social stressors (USGCRP, 2018; IPCC, 2018). One mental health professional, who specializes in treating families from communities of color, said:

> *"I do think communities of color are addressing some of these issues, but just not in the language of climate change. I think for them it may be more of a language of just trying to survive and live."*

In these cases, individuals might not reject climate change language, but instead find it less important than other, more immediate concerns. Practitioners make the connection to wider climate change issues, but do not ask individuals to focus on those connections.

The third framing strategy involved avoiding the terminology of climate change altogether. This was particularly an issue for practitioners who worked in politically conservative communities who were less willing to discuss climate change (Leiserowitz et al., 2020). Practitioners using this framing strategy integrated personal experience by emphasizing what impacts individuals were already experiencing without mentioning how climate change was directly related. A practitioner at a research institution described how they used this framing when describing climate change events in outreach:

> *"And I do a lot of going out and talking to people and I don't say, 'climate change,' I say, 'flooding.' I say, here's what we observed, here's the, you know, the tide gauges and here's the way, this is what we're seeing, those higher water levels and more flooding. So it kind of sidesteps the political argument."*

Emphasis on local scale

Most programs regarding adaptation behaviors focus on the local scale, particularly city or county governments. While 12 of the 29 interviewees work directly for local governments, another 12 interviewees said that they work in partnership with local governments (and related entities such as planning contractors). One funder at a federal agency, for example, said that they require the education programs they fund to partner with local planning entities to increase their impact:

> *"We recognized that these projects need to be absolutely practically rooted in these plans because these plans are inherently about that community. … And now we only fund projects that have what appear to be robust partnerships with those local planning entities and are integrating those [climate action] plans in meaningful ways, not just lip service."*

Even practitioners who did not work with local governments emphasized their importance for adaptation. For example, one researcher at an education institution, when describing the types of behaviors they hoped people would engage in, emphasized civic engagement at the local level:

> *"Engaging with the lowest level of government that they can. We argue a lot about federal level stuff, but really, it's your city council person, or your homeowners' association, where you can make some really significant changes pretty quickly."*

Working within the boundaries of local governments also meant that local political challenges played an important role in program design and implementation. For example, many local government practitioners described having challenges obtaining or maintaining funding (n=6) or getting political support from certain departments or politicians within their government (n=10).

These political challenges also affected what kinds of behaviors local government officials were likely to support through their programs, particularly with regard to civic engagement. One city sustainability officer, for example, said that while political civic engagement was desirable, they could not formally support it because doing so could lead to their program's termination:

> *"They start to get involved, whether it's budgeting priorities of the city, or whether it's elected officials, or politics, or whatever it may be. So, we're certainly seeing that shift, I would be loathe to say that this program is intended to shift the politics because that would be something that could get the program removed."*

Not all local government officials avoided political engagement, however. Another city sustainability officer said that only political civic engagement would protect their programs:

> *"What I fear will happen is this administration is done in two years where it [inaudible] termed out and if people vote the other way, we could be very easily sued. But all our departments' work … we need to show support for it."*

Partnerships also played an important role for local government officials who implement programs related to adaptation behavior. These partnerships included other departments and local

and national non-governmental organizations. Several local government practitioners (n=5) mentioned partnerships with universities to gather information about local climate change impacts or about the community itself. Only one practitioner mentioned working with local government and a university as a partner in developing or testing an intervention related to adaptation behavior, developing a citizen science program.

Changes to programming in 2020

The lead author also emailed interviewees in July 2020 to follow up on their practices and determine if they had made any major changes since their interviews in 2019. Thirteen respondents replied. The change mentioned most often, unsurprisingly, was movement to virtual programming in response to the COVID-19 pandemic. No practitioner mentioned that their efforts had ended, and four mentioned that their programming had expanded. Of those who expanded their programming, two mentioned developing new outreach programs to focus on racial and environmental justice, including the development of resilience hubs; and two mentioned new partnership programs to better connect stakeholders and the public. Of the other practitioners, one practitioner mentioned developing a new program theory of change, and three mentioned adding new topics to their practices, including a greater focus on holistic approaches and climate equity. Moreover, the respondent who was originally quoted as not including psychosocial antecedents in their programming noted that they have changed their programs to now include them. Finally, one city sustainability officer left their position, but their city has made no other major changes.

Discussion

This exploratory study examines how practitioners from across the U.S. conceptualize and support adaptation behaviors, and to what extent those behaviors align with existing adaptation

behavior research. Guided by a synthesized, scholarly model of personal and household adaptation behavior (Chapter 3), we asked practitioners about critical elements of program design, such as targeted behaviors and desired outcomes in ways that can inform future research and practice. Our study suggests U.S. practitioners seek to support multiple types and combinations of adaptation behaviors, for a diverse set of outcomes, and through a variety of interventions. Practitioners tend to focus more on contextual rather than psychosocial antecedents of adaptation behaviors, yet nearly all practitioners describe informational interventions as relevant to their work. Their overall attitudes toward the role of behavior in adaptation vary. All practitioners were able to name specific personal and household actions relevant to adaptation, but a few appeared to have difficulty broadly conceptualizing behavior and adaptation as related. Many of the practitioners who were able to connect behavior and adaptation did so by describing behavior as playing an important role in empowering communities. Most practitioners incorporated individuals' personal experiences when communicating with the public about climate change, either by linking individuals' experiences to climate change or using experience as a way to avoid language of climate change. Finally, most practitioners conducted activities at the local scale.

Overall, findings suggest that research on adaptation behavior has not been deeply integrated into practice, and that practitioners' experiences have not been sufficiently considered by researchers. This is not surprising given that adaptation behavior research is a small and emerging field (Chapter 2; van Valkengoed & Steg, 2019b). This study contributes to future research in this area by illustrating conceptual differences in how researchers and practitioners describe and support adaptation behavior. Furthermore, this study applies a synthesized scholarly model of adaptation behavior (Chapter 3) to show several specific differences between

researchers' and practitioners' priorities. These insights can provide the basis for improved communication between researchers and practitioners to support greater impact of future scholarship.

Practitioners are divided on how they conceptualize adaptation behavior

All interviewed practitioners conduct work relevant to personal and household adaptation behavior and named specific behaviors, but only some integrated behavioral research insights in explicit and strategic ways. For example, some practitioners described informational interventions as part of their program design but did not consider relevant psychosocial antecedents that would strengthen the link between their intervention and behavior change (Chapter 3; Steg & Vlek, 2009), or using structural interventions such as installing cool roofs but did not link those activities to specific personal and household behaviors. In contrast, other practitioners did incorporate behavioral insights into their activities, carefully designing programs to support individuals' enacting behaviors such as developing emergency preparedness kits or policy advocacy. Still others stated that behavior was not relevant to their activities, even if those activities involved engagement with individuals from the public such as public events. Thus, practitioners were divided among those who *explicitly* incorporated behavior; i.e., deliberately supported adaptation behaviors, those who *implicitly* incorporated behavior; i.e., described specific adaptation behaviors relevant to their programs but did not deliberately seek to support them, and those who *rejected* behavioral activities; i.e., engaged with the public but did not think behavior was relevant to their goals.

These divisions among practitioners did not appear to be related to their organization type (e.g., local government or non-government agency) or the scale at which they worked (e.g., local or national), but instead to the way they conceptualized behavior and their potential role in

changing it. These differences are summarized in Table 4-7. Practitioners who rejected behavior tended to describe it as individualized actions to reduce negative environmental impacts, with a focus on consumer actions. Those who explicitly or implicitly incorporated behavior described behavior as actions that individuals can take to protect themselves and/or to promote social changes. This definitional tension is also present in the adaptation behavior literature, where some researchers describe consumer pro-environmental behaviors such as recycling or reducing driving speeds as adaptation behaviors, while others identify behaviors related to personal protection and addressing broader system change (Chapter 2).

Table 4-7. Matrix summarizing conceptual differences among practitioners who explicitly incorporate adaptation behavior, implicitly incorporate adaptation behavior, or reject adaptation behavior as part of their public-facing activities

		Definition of adaptation behavior	
		Actions to promote protection and/or social change	**Consumer actions to reduce GHG emissions**
Purpose of behavior change interventions	**Enabling choice**	Explicitly included	*Not in sample* [a]
	Influencing behavior	Implicitly included	Rejected

[a] No interviewed practitioners fell into this category, possibly because those who are carrying out activities in this area might not use language of climate change adaptation to describe their work.

Moreover, the interviews revealed differences in how practitioners viewed their role in changing behavior. Practitioners who explicitly incorporated behavior described their role as supporting and enabling individuals' choices, whereas those who implicitly incorporated or rejected behavior believed that behavior change programs were designed to influence individuals to take on behaviors they did not choose. These differences reflect a similar distinction present in several bodies of literature relevant to behavior, particularly in environmental education, which

describes *emancipatory* and *instrumental* behavior change approaches (Wals et al., 2008; Wals & Jickling, 2002). The emancipatory approach involves creating learning experiences that teach new ways of thinking and empower participants to take on multiple new behaviors. These experiences are meant to change power structures through collaboration, and they include development of shared outcomes and an iterative process that evolves over time (Wals et al., 2008). The instrumental approach involves determining prescribed specific behaviors and then designing a program to encourage individuals to take on those behaviors (Wals et al., 2008; Wals & Jickling, 2002).

Similar approaches have appeared in other bodies of literature under other names, including transformation and satisfaction-focused approaches in the collaborative planning literature (Bush & Folger, 2004), participatory and information deficit approaches in the communication literature (e.g., Suldovsky, 2017), and critical and traditional approaches in the service-learning literature (Mitchell, 2008). All of these approaches describe either supporting individuals' autonomous decision-making through participatory collaboration (i.e., emancipatory, transformation, participatory, critical) or finding ways to influence individuals to enact the behaviors desired by experts or policymakers (i.e., instrumental, satisfaction, information deficit, traditional).

The interviewed practitioners who implicitly used or rejected behavior change methods appeared to want to avoid using the instrumental approach but did not see an alternative to it. Rather than shifting to an emancipatory approach, however, they avoided the language of behavior change altogether. This suggests that some practitioners may have an interest in an emancipatory approach but may not be aware of it.

Differences in researcher and practitioner priorities as revealed by the synthesized model

This study applied a synthesized scholarly model of adaptation behavior (Chapter 3) to identify impacts, contextual antecedents, psychosocial antecedents, behaviors, and outcomes that practitioners identified as relevant to their work, and we identified several areas where research and practitioners have different priorities.

For one, practitioners may over-emphasize the importance of knowledge compared with researchers. Practitioners named knowledge of climate change second-most often as the psychosocial antecedent relevant to their activities (after experience, which was prompted); learning was the second-most mentioned behavior; and information provision was tied for the most-often mentioned intervention. Moreover, several practitioners named increased awareness and knowledge change as a desired outcome. Overall, this suggests that practitioners prioritize knowledge change as an important component of their activities with the public. In contrast, extensive behavioral research has shown that understanding an environmental problem alone is not sufficient for an individual to take action to address it (Kollmuss & Agyeman, 2002; M. J. Stern, 2018), and that other factors such as self-efficacy and social norms may play a more important role (van Valkengoed & Steg, 2019a; Wilson et al., 2020). This difference between researchers and practitioners may have a basis in adaptation policy research, which suggests increasing awareness and knowledge of climate issues as the first step in building public adaptive capacity (e.g., Huq & Ayers, 2008), and does not identify other psychosocial factors that might be relevant. Thus practitioners' responses may reflect the fact that the broader adaptation literature has not integrated behavior change insights until recently (van Valkengoed & Steg, 2019a). Moreover, because many practitioners expressed discomfort with attempting to influence individuals' behaviors, even among practitioners who explicitly incorporated behavior, the

emphasis on knowledge may be *because* knowledge is only weakly linked to behavior change. By targeting knowledge alone, a practitioner has engaged an individual without appearing to exercise influence over that individual. However, this means that the practitioner may miss opportunities using other approaches (e.g., emancipatory approaches) that support behaviors that can have both individual and social benefits.

Interviews also revealed factors that researchers may under-emphasize compared with practitioners. First, practitioners described trust and mistrust, and particularly (mis)trust in government, as a major reason why their efforts failed or succeeded. In contrast, research on adaptation behavior has not emphasized it. A meta-analysis by van Valkengoed & Steg (2019a) showed that trust in government had the second-smallest effect size, and trust in the effectiveness of implemented adaptation measures had the smallest one, among the 13 psychosocial antecedents measured (van Valkengoed & Steg, 2019a), and Wilson et al.'s (2020) research synthesis found that factors related to trust (such as social capital) have a mixed relationship with behavior. One reason for this difference may be due to how practitioners and researchers conceptualize trust. Trust in government is a complex construct, including sub-constructs such as trust in competence, credibility, care, and value similarity, and is often situationally specific (Poortinga & Pidgeon, 2003). Practitioners may not define trust in that way. We believe that practitioners' emphasis on mistrust warrants further attention, partly because other fields of environmental research suggest that trust is not sufficient to support behavior and that mistrust is sufficient to prevent it (Gifford, 2011; Kasperson et al., 1992).

In addition, practitioners place a greater emphasis on social context and equity than adaptation behavior research has done to date. More than eighty percent of practitioners named social inequalities as relevant to their efforts. In contrast to research on climate change

adaptation more broadly (e.g., Adger et al., 2006; O'Brien et al., 2004), research on adaptation behavior has not focused deeply on these issues (Chapter 3). Climate change impacts individuals and communities unequally, with impacts being disproportionally greater for communities already experiencing stressors including poverty, exposure to pollution, and inadequate health care (IPCC, 2018; USGCRP, 2018). Adaptation behavior researchers should therefore account not only for individuals' varying abilities to carry out specific behaviors, but also for different outcomes depending on who performs the behavior.

Moving forward

As climate change increasingly affects individuals' lives, it is important for both researchers and practitioners to consider ways to support individuals' ability to adapt through enacting personal and household behaviors. One way researchers can do so is by working with practitioners to help them shift from *rejecting* or *implicitly* incorporating adaptation behavior in their activities to *explicitly* doing so.

This shift will require providing opportunities to learn about psychosocial factors other than knowledge and alternatives to instrumental behavior change approaches. To aid this shift, one psychosocial factor that researchers can explore further is personal experience. While practitioners place more emphasis on knowledge than researchers do, many practitioners also draw on individuals' personal experiences with climate change as part of their activities. Personal experience of climate change has been closely linked to knowledge development (Reser & Bradley, 2020), but the link between experience and adaptation behavior is not well understood in the literature to date (Reser & Bradley, 2020; Wilson et al., 2020). By linking their activities to individuals' experiences of climate change, practitioners play an important mediating role by helping individuals interpret their experiences. Practitioners who *implicitly*

incorporate behavior may see their role as interpreters to solely support knowledge development. However, personal experiences can also be linked to changes in other psychosocial factors including risk perception and emotions (Reser & Bradley, 2020). Some practitioners who *explicitly* incorporate behavior, such as the federal communications specialist who emphasized integrating emotions in their communications, described using interpretation strategies in this way. Positioning the practitioner as aiding interpretation of individuals' experiences with climate change can help clarify their role in supporting individuals' adaptation behavior, as well as provide opportunities for exploring how different interpretations might link to potential behavior. Such proposed research can help lend clarity to an important area of adaptation behavior scholarship and help improve practitioners' future engagement strategies.

One promising area of research for identifying such techniques may be scholarship on climate change and mental health, which includes guidance on how to interpret experiences to enable new choices (e.g., Clayton et al., 2014). Because practitioners who did not explicitly incorporate behavior expressed discomfort with attempting to influence behavior, it is important to identify techniques that support interpretation of experiences in ways that enable adaptation behaviors. Our interviews indicate that while practitioners value mental health, related strategies have been overlooked in much adaptation behavior practice to date. Incorporating mental health may therefore help advance more explicit incorporation of behavior into adaptation practice.

Another way to advance more explicit incorporation of behavior is to consider how to align behaviors with broader social and policy goals. Several practitioners suggested that individual and social change are mutually exclusive, and this argument appears in other areas of research. Pro-environmental behavior research, for example, has also found that individuals often perceive a conflict between personal consumer action and collective political action (Hall et al.,

2018; E. M. Hamilton et al., 2018). Adaptation behavior literature also describes a similar conflict under the names *incremental change* for personal, short-term actions and *transformational change* for collective, long-term actions (Fischer, 2019; Wilson et al., 2020), and most research publications have focused on only one or the other (Wilson et al., 2020). However, personal behaviors can support broader policy goals. For example, in climate change mitigation research, Williamson et al. (2018) illustrate how personal and household mitigation behaviors support emissions reduction proposed in the Drawdown framework (Hawken, 2017). Moreover, Raimi (under review) outlines four guidelines for supporting mitigation behaviors that align with broader policy goals, including selecting behaviors that are most effective and communicating how they achieve desired outcomes. Similar work is needed for adaptation behaviors. Rather than framing adaptation behavior as a choice between either incremental or transformative change, researchers can identify how and what combinations of behaviors might support both.

Finally, research can further explore what barriers might prevent practitioners from explicitly incorporating adaptation behavior into their activities. One barrier, for example, may be political support, which was mentioned in many interviews. These political barriers may also be affected by factors that have been under-emphasized in adaptation behavior research, including trust in government and social equity concerns. A second potential barrier may be related to practitioners' professional development on behavior change. Disciplines such as policy and planning do not always provide guidance on behavior change approaches, even when behavior is relevant to desired outcomes (Kollmuss & Agyeman, 2002), and research on adaptation planning has also often overlooked behavioral dimensions (Fazey et al., 2010). A few interviewed practitioners mentioned being taught to think about the role of behavior in a certain

way, such as the practitioner who mentioned it has been "*ingrained*" in them not to use instrumental approaches. Practitioners' perspectives may have developed based on formal instruction, informal experiences, or both. Understanding how practitioners came to understand the role of behavior can help enhance future professional development so that they learn to incorporate behavior more explicitly.

Limitations

Our exploratory study has several limitations. First, due to its qualitative nature, results are not designed to be statistically representative of the general population of practitioners. Notably, nearly all local government interviewees worked for cities that already supported sustainability and climate action, which is not the case for all cities in the U.S. (Bassett & Shandas, 2010). Second, due to the differences in language that practitioners use when talking about both human behavior and climate change adaptation, we do not know the actual population of practitioners across the U.S. conducting work in this area. As suggested by our interviews, some practitioners who are engaged in relevant work do not recognize it as such. Thus, there are likely to be other practitioners in the U.S. who are supporting adaptation behavior but that we were unable to identify. Third, our sample included few people of color. Communities of color, particularly those who are economically marginalized, are likely to experience harsher climate change impacts sooner (USGCRP, 2018), but, as one of our interviewees noted, they may be less likely to describe these issues using climate change language. This limitation also reflects the issue that people of color are underrepresented at environmental organizations, particularly in leadership positions (Taylor, 2014). Next, our study focused on the U.S. The cultural context of the U.S. differs from the rest of the world, particularly with regard to climate change attitudes (Pew Research Center, 2019). Some insights from our study may therefore not apply to other

countries. Finally, we experienced audio quality issues with a few interviews, particularly ones conducted by phone, which resulted in a loss of less than 0.5% of interview transcript text.

Conclusion

Supporting personal and household behavior in the U.S. is important to achieving climate change adaptation goals. Engaging in adaptation behaviors can empower individuals to protect themselves in the face of immediate climate impacts (Grothmann & Patt, 2005), and work with others collectively to advance longer-term adaptation outcomes (Wilson et al., 2020). We do not suggest that adaptation behaviors should replace other adaptation efforts such as policy and infrastructure changes, but instead that behaviors should be aligned with these changes and explicitly incorporated to achieve adaptation goals.

One of the purposes this article is to help practitioners intentionally support adaptation behaviors that have personal, social, and environmental benefits and thus, to advance short- to long-term adaptation goals. Many practitioners are already implicitly working towards supporting adaptation behaviors, but more could do so explicitly. Our framework (Chapter 3) can help researchers and practitioners identify areas where they can learn from each other. For example, researchers can learn from practitioners by further investigating the roles of trust in government and social equity in adaptation behavior intervention success. Practitioners can learn from researchers about behavioral and intervention options that they may not be aware of, such as emancipatory behavior change approaches. They can also use research insights to design programs that explicitly align behaviors and interventions with their overall adaptation goals. By working together researchers and practitioners can better support human well-being through current and upcoming global environmental changes.

CHAPTER 5

Conclusion

The goal of this dissertation was to present a definition and framework to support increased adoption of climate change adaptation behavior into research and practice, and to demonstrate how this definition and framework applies to current practices in the United States. Personal and household adaptation behavior was first conceptually described in climate change psychology research in the 1990s (P. C. Stern, 1992) and has been included in empirical studies since the mid-2000s (Grothmann & Patt, 2005), but is only beginning to be formalized as its own field of research. Overall, personal and household behavior can play an important role in supporting climate change adaptation goals, and recognition of its role is growing rapidly (van Valkengoed & Steg, 2019a, 2019b; Wilson et al., 2020). Adaptation is a complex, long-term, and evolving challenge, and the necessary responses will continue to change over time (IPCC, 2018; Milly et al., 2008). Therefore, this dissertation is not meant to provide a single prescribed behavior or behavior change strategy but to provide guidance for conceptualizing adaptation behavior, and options for integrating behavior into future adaptation research and practice.

Key takeaways

Adaptation behavior is not the sole solution to achieving adaptation goals, but there are specific challenges that adaptation behaviors are best suited to address. Climate change adaptation will involve changes at every level of society, from governments to communities to individual citizens (Adger et al., 2005; IPCC, 2018). To date, adaptation research has focused

heavily on policy and planning strategies (e.g., IPCC, 2014), but individuals' behaviors determine whether many of these policies and plan achieve their intended goals (Fazey et al., 2010; Kollmuss & Agyeman, 2002). Furthermore, individuals can also advocate for governments to adopt new policies and plans as well as fill in gaps in adaptive capacity when the government fails to act. The latter are issues in the U.S., where action on climate change is highly politicized (Leiserowitz et al., 2020). Finally, some challenges, such as physical and mental health impacts of climate change, occur at the personal level, necessitating individual-level actions and interventions (Grothmann & Patt, 2005; Reser & Swim, 2011).

Moreover, adaptation behavior can take many forms and achieve multiple outcomes. For example, one critically important adaptation behavior highlighted in both research and practice is civic engagement, wherein individuals act with others to support and advance adaptation policy. These behaviors advance broader social change. However, protecting oneself from harm is also a potential adaptation behavior. One of the major purposes of adaptation responses is to protect individuals from climate change threats, be it harm to their physical and mental health, homes, or families and communities (IPCC, 2014, 2018). Thus, adaptation behavior is inclusive of both collective and personal actions and can achieve both collective and personal outcomes.

Because adaptation behavior can take many forms, it is important to consider the desired outcomes of these behaviors. Adaptation behavior affects and is affected by other individuals, whether it is acknowledged or not. For example, individuals can take on behaviors that benefit themselves while harming others (Eriksen et al., 2011), such as increasing the use of air conditioning (IPCC, 2014) or hoarding supplies (Preston & Vickers, 2014). This does not mean that all individuals should take on the same actions to adapt to climate change. On the contrary, different individuals will need to engage in different actions depending on their context and the

climate impacts they are facing. Adaptation behaviors must be selected carefully and intentionally so that they support outcomes that benefit – or at least do not harm – both broader systems and the individuals within them.

Finally, the emerging field of adaptation behavior is highly interdisciplinary. As demonstrated in this dissertation, research on adaptation behavior has emerged from multiple disciplines and fields of research (Chapter 2). Sometimes researchers from these different areas explore the same topic, such as the multiple terms for enabling versus influencing behavior change (Chapter 4), and other times they explore different topics, such as economic versus health dimensions of adaptation. The emerging field of adaptation behavior is inclusive of all these different disciplines and approaches, identifying areas of overlap and commonality between them. This field is also problem-focused, emphasizing how individuals can survive and thrive in the face of climate change impacts. Insights from all of these disciplines are necessary.

New contributions of this dissertation

This dissertation is the first research to propose personal and household adaptation behavior as a distinct concept. Research to date on adaptation behavior has not distinguished between personal and household behavior, and farming and resource management behavior (e.g., van Valkengoed & Steg, 2019a; Wilson et al., 2020). This distinction is important because the decision-making processes driving farming and resource management behaviors are often different from those driving personal and household behavior (e.g., Frank et al., 2011; Hyland et al., 2016). Moreover, personal and household behaviors are behaviors that nearly everyone can engage in. Individuals involved in agriculture and resource management can enact personal and household behaviors like migration or civic engagement, and so can individuals who live in cities. In contrast, individuals in cities cannot enact farming or resource management behaviors

like changing land management practices. This research represents a systematic understanding of the diversity of personal and household behaviors and how they might support climate change adaptation goals.

Furthermore, my dissertation highlights the importance of understanding contextual factors and how they shape what adaptation behaviors individuals might enact. While research from multiple disciplines suggests that contextual factors such as race (e.g., Loughran & Elliott, 2019), as well as income, age, and personal health (e.g., Sampson et al., 2013) play a major role in shaping potential adaptation behaviors, research syntheses on adaptation behavior have excluded contextual factors from their analysis (van Valkengoed & Steg, 2019a; Wilson et al., 2020). This exclusion likely has a historical basis in pro-environmental behavior research, which has focused on how contextual factors such as race and income predict personal concern about environmental issues (Gifford & Nilsson, 2014; H. Song et al., 2020), but not directly measuring what behaviors people might enact based on in these different factors. Climate change impacts people differently and unequally (IPCC, 2018; USGCRP, 2018), and these differences affect the resources available to individuals and thus the actions they are likely to take (Brown & Westaway, 2011). Moreover, individuals, particularly those who already have many resources, can take on actions that have harmful consequences for other people (Eriksen et al., 2011). Finally, practitioners place a strong and growing emphasis on recognizing difference and addressing inequality (Chapter 4), meaning that adaptation behavior research must address these concerns to increase relevance to practice.

Finally, my dissertation provides avenues for improving communication between researchers and practitioners, particularly in urban, Global North settings. Chapter 2 identifies behaviors aligned with climate change adaptation goals, providing options for researchers and

practitioners to determine what specific behaviors might be of interest to study and support. Chapter 3 provides a framework for program design, integrating multiple theories and illustrating how they might link to specific practices. Finally, Chapter 4 illustrates specific areas where practitioners and researchers may be using different language to describe similar concepts, such as behavior and interventions, as well as how practitioners are (and are not) already applying adaptation behavior research. My work shows that researchers and practitioners are interested in many similar problems but vary in how they describe and address them. This work presents researchers and practitioners with a potential common language to describe what adaptation behavior is, what theoretical factors might be relevant to it, and what kinds of interventions might support it. It also highlights areas where they might think about these issues differently and similarly.

Future research directions

Future research can first explore what adaptation behaviors individuals are enacting and what outcomes these behaviors achieve. While there are multiple options for adaptation behaviors, which behaviors are *adaptive* (i.e., provide benefits or prevent harm) depends on the outcomes of those behaviors. Currently, particularly in the U.S., it is unknown which adaptation behaviors individuals are enacting and what the outcomes of those behaviors are. Moreover, the adaptiveness of behavior also varies across contexts and over time, so there is a need to understand geographic and demographic variations in behaviors and outcomes.

This future research can include understanding potential differences in which adaptation behaviors individuals are adopting in Global North as compared with the Global South. Additional analysis of the publications included in Chapter 2 suggests that the small number of studies conducted in Global South nations may be more likely to focus on protective behaviors

(i.e., self-protection, household protection, and migration) compared with studies in Global North nations (Table 5-1). Further investigation is needed to understand whether these differences in the literature reflect the lived experiences of individuals in these different cultural contexts.

Table 5-1. Percentage of publications from systematic literature review (Chapter 2) who mentioned each type of personal and household adaptation behavior based on study location

	Global North only (n=54)	Global South only (n=8)	Both [a] (n=3)	Not specified (n=16)
Civic engagement	43%	25%	33%	44%
Consumption	28%	13%	0%	19%
Household protection	44%	75%	33%	38%
Learning	30%	13%	33%	13%
Lifestyle change	9%	-0%	0%	19%
Migration	17%	50%	33%	25%
Psychological coping	24%	13%	0%	63%
Self-protection	31%	63%	0%	25%

[a] Indicates studies with research components conducted in both Global North and Global South countries.

Furthermore, the associations there are among specific components of the synthesized model need more detailed investigation. While the model proposed in this dissertation synthesizes numerous concepts from several disciplines, further research can clarify relationships among specific model components. For example, while this model illustrates that psychosocial antecedents predict adaptation behavior, no research has compared which specific psychosocial antecedents (e.g., risk perception or self-efficacy) might better predict specific behaviors (e.g., civic engagement or household protection). Because there are many possible adaptation behaviors, it is important to understand and measure to what extent different antecedents predict specific behaviors.

Relatedly, there is a need to better understand public perceptions of adaptation as distinct from both mitigation and hazard mitigation. Adaptation and mitigation are potentially overlapping but distinct concepts (IPCC, 2014; SEG, 2007), yet in both practitioner interviews

(Chapter 4) and in adaptation behavior change research (Chapter 2), this distinction is not always clear. Furthermore, some practitioners used language of hazard response when speaking to more politically conservative audiences who were less likely accept climate change adaptation language (Chapter 4). Hazard response language also often overlaps with adaptation (e.g., van Valkengoed & Steg, 2019a; Wilson et al., 2020), but focusing on hazards alone can ignore necessary social changes that are a part of adaptation (Pelling, 2011). Research focusing on adaptation communication to date has focused on distinctions between mitigation and adaptation (e.g., Carrico et al., 2015), but not communicating adaptation on its own or in contrast to hazard communication. Future research can identify ways for adaptation communication to build on insights from both mitigation and hazard response literature.

Additionally, there is also a need to identify intervention strategies are most effective for supporting adaptive behaviors. Few practitioners measured or evaluated their behavioral programs' outcomes (Chapter 4), and few researchers have studied intervention techniques (van Valkengoed & Steg, 2019b). The framework proposed in this dissertation can help researchers and practitioners determine which outcomes, behaviors, and intervention techniques might be of interest for inclusion in empirical research design or potential logic models (Patton, 2008).Finally, future research can explore how the COVID-19 pandemic has (or has not) affected potential climate change adaptation behaviors. Because of the timing of my research, the COVID-19 pandemic had relatively little direct impact on the development of this dissertation. However, in the U.S. in particular, personal and household behavior changes (e.g., wearing face coverings, physical distancing) have emerged as a critically important component of the public response to COVID-19, and psychosocial factors such as social norms can play a role in what actions individuals are willing to carry out to adapt (Goldberg et al., 2020). Given the many

conceptual parallels between COVID-19 and climate change identified by researchers (e.g., Kunreuther & Slovic, 2020; Manzanedo & Manning, 2020), individuals' behaviors to adapt to COVID-19 might, or might not, affect their willingness and ability to adapt to climate change.

APPENDICES

APPENDIX 1. Practitioner Interview Protocols

City Sustainability Officers, Non-Governmental Organizations, Educators, and Contractors

Introduction

1. How long have you been at this position? How long have you been working on climate adaptation/resilience, at this job or at other jobs?

Expected climate change impacts

2. What climate change impacts are most relevant in your community? (PROBE: what about ones in the Short-term and what about in the longer term)
3. How concerned is the general public your community about climate change (not much, a little, a lot)?
    a. IF NOT MUCH: Why do you think that is? What other problems are they concerned about?
        i. Which of these concerns are you also concerned about addressing and why, within the context of climate change?

Existing stressors and resources (context)

4. What major impacts of climate change have people in your community experienced, if any? (PROBE: What have been their responses, what actions have they taken in the past)
5. What are some additional stressors that might worsen climate change impacts for your community/the communities you work with? (PROBES: vulnerable groups, groups impacted unequally, old infrastructure)
6. What are some resources/assets (PROBE IF NEEDED: financial resources, political connections, skills, community strengths) that the residents in your community(ies) have to address the climate change/other impacts?

Activities (if any)

7. Do you offer or plan to offer any programs to help residents in the communities you serve understand or prepare for climate change impacts (or related challenges/opportunities)?
   IF YES, PROBE AS NEEDED:
    a. What programs or activities are planned? When are these expected to be implemented?
    b. Have these activities been implemented? What were the results?

IF NO, END INTERVIEW

Expected adaptation behaviors

8. What do you expect individuals to do after participating in these programs/activities? Specifically, what behaviors/habits/plans do you expect them to change (if any)? PROBE FOR:
    a. In the short-term (including emergency preparedness)
    b. In the long-term
9. What (IF NEEDED: other) kinds of actions do you think individuals in the general public should do in response to the kinds of climate change impacts we've been talking about? PROBE FOR:
    a. Short-term
    b. Long-term
    c. How do you think these actions might be helpful?
    d. IF NONE: Why do you say that?
10. (IF NAME NEW BEHAVIORS IN Q9) Do you know whether people are doing these actions on their own (e.g., through grassroots or other means)? If not ,why not? What do think could be done to help individuals become more likely to take those actions?

Psychosocial antecedents of behavior

11. Are you targeting particular people to participate in these activities? If so, what techniques are you using? (PROBE FOR: What personalities, how do they define themselves within the community, what is most important to them, etc.)
12. How, if at all, do you expect these activities will change their thinking about climate change [IF NEEDED: long-term environmental change]? (PROBE FOR: Changes in risk perception, knowledge, emotions regarding the issue, perceived capacity to act, understanding of the issue, etc.)

Expected outcomes

13. What benefits do you think participants will get out of participating in these activities? (PROBE FOR: Short-term and long-term) PROBES IF NEEDED:
    a. Physical safety/health
    b. Mental health/stress reduction
    c. Household safety or protection
    d. Financial savings
    e. Anything else?
14. Do you think that these activities will provide broader benefits/harms reduction over time, i.e., benefits/harm reduction to people other than the participants themselves? PROBES IF NEEDED:
    a. Community benefits/harm reduction
    b. Environmental benefits/harm reduction
    c. Changes in policy or institutional support
    d. Other …

Wrap-up and future research

15. Is there anything else you would like me to know about your efforts working with the general public on climate change adaptation/resilience?
16. Are there other people you know of who are doing work in this area that you would recommend that I talk to?

Funders

Introduction

1. How long have you been at this position? How long have you been working on climate adaptation/resilience, at this job or at other jobs?

Expected climate change impacts

2. What climate change impacts do you work with? (PROBE: what about ones in the Short-term and what about in the longer term)

Existing stressors and resources (context)

3. How many projects are you currently funding?
4. What are some additional stressors that might worsen climate change impacts for your community/the communities you work with? (PROBES: vulnerable groups, groups impacted unequally, old infrastructure)
5. What are some resources/assets (PROBE IF NEEDED: financial resources, political connections, skills, community strengths) that the residents in your community(ies) have to address the climate change/other impacts?

Activities (if any)

6. What kind of activities to your grantees do to engage the general public on climate change adaptation? Are there any trends?

IF NO, END INTERVIEW

Expected adaptation behaviors

7. What do you expect individuals to do after participating in these programs/activities? Specifically, what behaviors/habits/plans do you expect them to change (if any)? PROBE FOR:
    c. In the short-term (including emergency preparedness)
    d. In the long-term
8. What (IF NEEDED: other) kinds of actions do you think individuals in the general public should do in response to the kinds of climate change impacts we've been talking about? PROBE FOR:
    e. Short-term
    f. Long-term
    g. How do you think these actions might be helpful?
    h. IF NONE: Why do you say that?
9. (IF NAME NEW BEHAVIORS IN Q9) Do you know whether people are doing these actions on their own (e.g., through grassroots or other means)? If not, why not? What do think could be done to help individuals become more likely to take those actions?

Psychosocial antecedents of behavior

10. Are there any psychological or social factors you encourage your grantees to think about in designing their programs?
    a. Are there any factors that they tend to use?

Expected outcomes

11. What benefits do you think participants will get out of participating in these activities? (PROBE FOR: Short-term and long-term) PROBES IF NEEDED:
    f. Physical safety/health
    g. Mental health/stress reduction
    h. Household safety or protection
    i. Financial savings
    j. Anything else?
12. Do you think that these activities will provide broader benefits/harms reduction over time, i.e., benefits/harm reduction to people other than the participants themselves? PROBES IF NEEDED:
    e. Community benefits/harm reduction
    f. Environmental benefits/harm reduction
    g. Changes in policy or institutional support
    h. Other …

Wrap-up and future research

13. Is there anything else you would like me to know about your efforts working with the general public on climate change adaptation/resilience?

Resilience Hub Implementer

1. Where did the idea for resilience hubs come from? (PROBE: Who proposed them and why?)
2. How many resilience hubs have been built? Where are they?
3. Where did you get funding from?
4. What role did community members play in developing resilience hubs? What strategies did you use to engage them? Were there any similar programs already in place, formally or informally?
5. Has Baltimore done any formal evaluation of resilience hubs? IF NO:
    a. About how many people have participated in the resilience hubs?
    b. I know that there is a goal for resilience hubs to be a place that people go to both during and not during emergencies. Has that been the case?
    c. Have you done any other measurements of outcomes?
6. What do people do at these resilience hubs? Can you walk me through what they do while they're there?
7. What are people expected to do after coming to a resilience hub to adapt to climate change impacts?
8. What do you think people should do to respond to climate change impacts?
9. What do you think participants will get out of participating in a workshop/coming to a resilience hub? (PROBE FOR: Short-term and long-term) PROBES IF NEEDED:
    a. Physical safety/health
    b. Mental health/stress reduction
    c. Household safety or protection

    d. Financial savings
10. Do you think that these workshops/resilience hubs will provide broader benefits/harms reduction over time, i.e., benefits/harm reduction to people other than the participants themselves? PROBES IF NEEDED:
    a. Community benefits/harm reduction
    b. Environmental benefits/harm reduction
    c. Changes in policy or institutional support

Incentive Program Researcher 1

1. As of two years ago (per your report), about 37,000 people have participated in this buy-out program. Has that number significantly changed?
2. Where do these buy-outs happen? Most of those cited in the report appear to be on the East Coast and the Midwest. (All of the case studies are in WI, MN, NC or NJ.) Is that accurate?
3. These buyouts usually happen post-disaster in anticipation of the next disaster, correct? Are there any places that are exploring or have done buyouts that hasn't experienced disastrous levels of flooding but might in the future?
4. Do people who take buyouts tend to move far away or stay in town? (EXAMPLE: New York offers 5% of cost for people who stay in same county)
5. How much have buyouts been tied to addressing other social vulnerabilities, e.g., are older people, lower-income people targeted or offered different support or incentives? Have any localities gotten feedback or pushback about that from their residents?
6. Is there anything else people do besides move? Is there anything else they're encouraged to do? Is there anything that they tend to do?
7. One issue that is mentioned in the report is holdouts, who seem to be somewhere between a third and a half of those who get offered buyouts. What distinguishes people who take buyouts from those who don't? Demographically, but also in terms of values, personalities, what is happening in their lives, etc.?
8. The report mentions both ecological and social benefits as potential outcomes of these buy-out programs. Do you know to what extent they are realized?
9. I'm intrigued by the story the report alludes to of neighbors in New Jersey and Wisconsin mowing vacant lots after the land was cleared out and even damaging (destroying?) pollinator gardens. In contrast, another area (Pierce County, WI) seems to be monitoring and protecting their vacant lot spaces for wildlife. What was different about these cases in terms of engaging with residents? Were there differences in terms of the residents themselves? PROBE FOR DIFFERENCES IN:
    a. What kinds of impacts they experienced
    b. Who they were
    c. What was important to them
    d. How satisfied they were with the buy-out process

10. Are there other people you would recommend that I talk to about their experiences with these programs (e.g., people who implemented or evaluated them)?

Incentive Program Researcher 2

1. How long have you been working on buy-out programs?
2. The buy-out programs that I saw in your past research appear to be mostly related to flooding, correct? Are there buy-out programs you're aware of for other kinds of climate change impacts, such as wildfires or sea level rise?
3. Have these programs been linked to climate change specifically or are they treated as something separate from climate adaptation by administrators/implementers?
4. Do you think, or have you observed, that people who participate in buy-out programs make any links between these impacts that necessitate the buyouts and climate change?
5. How much have buyouts been tied to addressing other social vulnerabilities, e.g., are older people, lower-income people targeted or offered different support or incentives? Have any localities gotten feedback or pushback about that from their residents?
6. Do you have data overall on whether people who take buyouts tend to move far away or stay in town? (EXAMPLE: New York offers 5% of cost for people who stay in same county)
7. Is there anything else people do besides move? Is there anything else they're encouraged to do? Is there anything that they tend to do?
8. One thing I thought when reading your work on buyouts that there seems to be two major types of desired outcomes: safety and physical protection from flooding on the one hand and personal and community well-being on the other. However, they don't seem to be mutually supportive and can even be in tension with each other. Would you agree with that characterization? If so, do you think there are ways for buyouts to support both of these outcomes and if so, how (PROBE FOR EXAMPLES)? If not, what do you think should be done?
9. You've mentioned in papers that you've published that major psychosocial factors relevant to buyouts are place attachment, social capital, and risk perception – not just risks related to natural hazards but also e.g., crime. Is that correct? Are there other psychosocial factors that you think are relevant to people's experiences with a buy-out? (PROBE FOR: Whether they take a buy-out, whether they report improvements to their lives after a buy-out)
    a. Probe: How have you seen trust play out in particular?
10. I interviewed another firm about their experiences with buyout programs and one thing they mentioned were cases where neighbors mowed vacant lots after a buyout and even damaging (destroying?) pollinator gardens. They also had cases where neighbors monitored and protecting the nearby vacant lot spaces for wildlife. Have you run across cases like those? If so, what was different about these cases in terms of engaging with residents? Were there differences in terms of the residents themselves? PROBE FOR DIFFERENCES IN:
    a. What kinds of impacts they experienced

b. Who they were
c. What was important to them
d. How satisfied they were with the buy-out process

Mental Health Practitioners

I have a few questions about interactions that you have had with your clients. Please do not share information about specific clients – these questions are meant to ask about work with your clients overall.

1. Can you tell me about the community that you work with? (PROBE FOR: Demographics, issues and stressors facing the community)
2. How does climate change impact the clients that you work with?
3. What kind of climate impacts have you encountered among your clients? Do they mention specific impacts that they're thinking about (e.g., sea level rise, flooding, wildfires)?
4. Do clients mention specific events that have happened to them?
5. What other kinds of stressors are clients facing when dealing with climate impacts? Are there any that they tend to mention?
6. What kinds of actions do you tend to recommend for clients who are experiencing stress or other mental health impacts of climate change?
7. Are there other actions that clients have mentioned doing about climate change impacts?
8. Do you work with or have you worked with other organizations (e.g., city governments, NGOs) about responding to climate impacts? (PROBE IF NEEDED: For example, participated in a community event or been part of the response to a climate impact event such as a flood?) If so, can you tell me any major lessons learned from those experiences?
9. Research suggests that psychological factors like pre-existing levels of stress, perceived ability to act, and problem framing play important roles in people's mental coping with climate impacts. Do you find that matches with your experience? Are there other psychological factors that you think play a role?
10. Are there any outcomes other than mental health improvements that you think individuals might achieve through this process? (POSSIBLE PROBES: Community benefits, environmental benefits)

APPENDIX 2. Practitioner Interview Codebook

Appendix Table 1. Detailed practitioner interview codebook

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
Behavior	Civic engagement (non-political)	Acting alone or with other people to support or advance community adaptation goals	Mentions a non-political action such as joining a community group or volunteering	Mentions a political or activist action such as contacting an elected official or voting	Source: Chapter 2	"I think the biggest thing, really, as an individual is being connected to your community and your neighbors."
Behavior	Civic engagement (political)	Acting alone or with other people to support or advance climate change adaptation policies or broader social change	Mentions a political or activist action such as contacting an elected official, voting, or policy support	Mentions a non-political action such as joining a community group or volunteering	Source: Chapter 2	"And if you don't like something happening in your community, go to your board and ask them to change it. You know, become involved, become a leader. Speak out. This is your community. Make change the way you want to see change."
Behavior	Consumption action	Actions to benefit the environment and/or conserve natural resources, based around product	Mentions actions related to purchase or use of consumer goods; taking	Mentions long-term lifestyle changes rather than single	Source: Chapter 2	"Trees, rain barrels, rain gardens, permeable pavement, or more natural, native fruit planting"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		purchase and use decisions	action with environmental benefits	produce-based decisions		
Behavior	Psychological coping	Mental management of stress associated with the impacts of climate change	Actions to manage stress or promote mental health, could be alone or with others	Mentions mental health but not practices related to fostering it	Source: Chapter 2	"And so sometimes it's a matter of when you're dealing with multi stressed families first to kind of clear the plate and kind of access their own agency. … To kind of get them grounded again, get them fully themselves."
Behavior	Household protection	Physical actions to proactively protect one's family members, house, and/or possessions from specific climate change impacts	Actions to protect one's property or household from climate impacts (e.g., purchasing sandbags)	Moving away or taking action only to protect oneself	Source: Chapter 2	"It may be something smaller, like installing flood vents or elevating their utilities"
Behavior	Learning	Building new understanding about adapting to climate change	Changes in thinking, attitudes, skills; seeking or sharing information	Description of an educational program	Source: Chapter 2	"They knew the climate was changing. They didn't quite get how that was going to affect them, and through these conversations that has become more clear and they're very eager to learn more about that and what they can do."
Behavior	Lifestyle change	Making long-term changes to one's way of living	Long-term changes to behavior (e.g.,	Short-term changes	Source: Chapter 2	"Build sustainable communities around local food production"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
			growing one's own food)			
Behavior	Migration	Permanently leaving one's original home in response to climate change impacts	Permanently moving away to a new house	Short-term evacuations with the intent to return	Source: Chapter 2	"So, for some people, the answer may be, 'Hey, I just need to move.' Like, 'I can no longer accept this risk and no amount of elevation is going to be enough to keep me safe at the right level.'"
Behavior	Self-protection	Personal physical actions, planned or unplanned, to protect oneself from specific climate change impacts	Actions to protect oneself personally from an impact (e.g., drinking water during a heat wave)	Actions to protect one's property or household from climate impacts; long-term actions	Source: Chapter 2	"We get people signed up for Code Red, which is a system by phone or text that you can get notifications of extreme weather."
Behavior	Other behaviors	Named actions that do not fit into existing categories; may also include maladaptive behaviors	Any action relevant to adaptation that does not fit into the above categories	Actions that are not relevant to adaptation (e.g., recycling)	Source: Chapter 2	"We've had a lot of conversations with people where they're like, 'Look, I would rather sit and sweat in my house even with my elderly parent or something than go down to a cooling center.'"
Climate change impacts	Climate change impacts (general)	Describes addressing climate change in a general sense	Does not name a specific climate change impact	Describes a specific climate change impact	Source: Chapter 2	"Everything."
Climate change impacts	Changes to hydrological cycles and water	Changes to major water sources, either	Changes in snowpack size or melting time,	Changes in precipitation	Source: Chapter 2	"lack of snowpack"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
	supply	in amount or timing of availability	changes in aquifers or other water sources			
Climate change impacts	Disease vectors	Changes in where diseases may spread or what time or year they might occur	Describes changes in where, how, and when people might contract climate-sensitive infectious diseases	Describes other events that might impact health (e.g., heat waves)	Source: Chapter 2	"infectious disease vectors"
Climate change impacts	Drought	Medium- to long-term lack of rainfall in an area	Describes changes in water availability, lengthy but discrete events where an area did not receive sufficient rainfall	Long-term changes to precipitation, such as permanent reduction in rainfall	Source: Chapter 2	"drought"
Climate change impacts	Extreme weather events	Discrete, damaging weather events that have been linked to climate change such as hurricanes, storms	Names discrete events such as storms or hurricanes	Describes other events such as floods, heat waves, or long-term changes	Source: Chapter 2	"increased frequency and intensity of extreme events. Whether those are fires or other sort of natural disasters"
Climate change impacts	Fire	Changes in intensity, location, or timing of wildfires	Describes changes in where, how, when, and how often fires might occur in the area	Describes long-term changes in temperature, drought or heat wave events	Source: Chapter 2	"grass and wildfires, grassfires"
Climate change impacts	Flooding	Sudden increases in local water level, rises to point where no	Describes discrete flooding events	Describes long-term changes in water levels	Source: Chapter 2	"flooding"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		longer contained (within rivers, lakes, reservoirs, etc.)	(including sunny-day flooding)			
Climate change impacts	Heat waves	Multi-day events where temperatures are much hotter than normal	Describes discrete heat wave events, extreme heat events	Describes long-term temperature change	Source: Chapter 2	"more frequent and severe heat waves"
Climate change impacts	Multiple stressors and secondary impacts	Describes ways that climate change exacerbates/is exacerbated by other existing problems, or ways that climate change has indirect impacts on people	Describes how a climate change impact has additional impacts on community members	Describes only a single climate change impact	Emergent code	"Well, what they're concerned about is, um … the direct impact, but we've had a lot of events, a handful of events, that have been sort of two-fold, like flooding would [happen] two counties over, overwhelms our water system and we have a water quality notice for two weeks."
Climate change impacts	Precipitation changes (more/less rain)	Gradual and long-term changes in how much rain an area receives	Describes long-term changes in precipitation (more or less)	Describes discrete flooding events or drought events	Source: Chapter 2	"Certainly wetter over, about 20% more rain"
Climate change impacts	Sea level rise	Gradual and long-term increases in water level, typically in coastal areas	Describes long-term changes in water levels	Describes discrete flooding events (including sunny-day flooding)	Source: Chapter 2	"sea level rise"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
Climate change impacts	Temperature and seasonality changes	Gradual and long-term change in the average temperature in an area	Long-term warming; changes in growing seasons	Discrete heat events, heat waves	Source: Chapter 2	"our winters are a little warmer"
Climate change impacts	Other impacts	Other impacts of climate change not already listed	Impacts of climate change that do not fit into other categories	Impacts of climate change that do fit into an existing category	Emergent code	"ocean acidification"
Contextual factors: Personal context	Age	Describes age as a factor that constrains how climate impacts people or what actions they might take	Describes effects of age (e.g., youth, older people)	Describes health or other ability-related issues	Source: Chapter 3	"We have definitely a good population of seniors and that's probably a more vulnerable population"
Contextual factors: Personal context	Mental health	Existing mental health issues that affect how climate impacts people or what actions they might take	Names mental health issues that affect a person's ability to act (e.g., trauma)	Names age or physical health issues	Source: Chapter 3	"We're really trying to address, I would say it's more about trauma that we're trying to address. Thinking about trauma and the component of resilience and how we're thinking about the fact that people are going through everyday trauma in addition to this, what happens when that is exacerbated by a natural disaster?"
Contextual factors: Personal context	Physical capabilities	Physical ability to carry out tasks, affecting how climate impacts people or	Names physical capacities (e.g., disability) that might affect an	Names age or other health issues (e.g., asthma)	Source: Chapter 3	"Critical services to those that might need support very, in emergency situations,

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		what actions they might take	individual's ability to act			medically, or just, mobility, those types of issues."
Contextual factors: Personal context	Physical health	Existing physiological health issues that affect how climate impacts people or what actions they might take	Names physiological health issues that affect a person's ability to act (e.g., asthma)	Names age, mental health, or physical ability issues	Source: Chapter 3	"When you start to look at things like asthma related to grass fires"
Contextual factors: Personal context	Socioeconomic status	Personal factors such as income, wealth, or owner/renter as a factor that affects how climate impacts people or what actions they might take	Describes factors related to an individual's ability to afford to take a certain action	Describes historical or social problems related to economic inequality (e.g., inadequate housing)	Source: Chapter 3	"So any external stressor that causes a home to flood or needing more, higher energy costs, higher air conditioning costs, all these have an exacerbating effect on existing vulnerabilities."
Contextual factors: Socioecological context	Community resilience	Resources wherein people in a community provide benefits to each other	Describes existing social support or close social networks	Programs where people work together in groups	Emergent theme	"We have a strong network of community organizations as well as over 80 neighborhood associations in [CITY]. It's not that big of a city. So, I think that creates a level of social connection and resources for people."
Contextual factors: Socioecological context	Culture	Shared beliefs, values, and identities among a group of people	Traditions, activities, etc. that are shared by a group	The sense of personal connection or attachment	Source: Chapter 3	"cultural backgrounds"

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
				between individuals		
Contextual factors: Socioecological context	Economic inequality	Community-level factors related to how class and/or wealth might affect climate impacts or actions that people might take	Describes historical or social problems related to economic inequality (e.g., inadequate affordable housing)	Describes factors related to an individual's ability to afford to take a certain action	Emergent code	"We are focusing more of our direct outreach and community engagement with communities of color and low-income communities and those who are facing a high, disproportionate higher burden of environmental contamination."
Contextual factors: Socioecological context	Existing demographic change	Changes in population that already exist and may be accelerated by climate change	Population displacement or gentrification	Discussion of economic or racial inequality that does not mention demographic change	Emergent code	"climate gentrification"
Contextual factors: Socioecological context	Existing infrastructure	Existing physical structures and connections that might affect how climate impacts people or what actions people might take	Describes how quality of existing infrastructure may make adaptation behavior easier or more difficult (e.g., whether flood controls are sufficient)	Describes changes in infrastructure to change behavior related to adaptation	Source: Chapter 3	"I think as far as the organization goes and hard infrastructure investments, the majority of those are being made in terms of public works. [Inaudible] infrastructure, so, water, drainage, that kind of stuff."
Contextual factors:	Existing policy	Specific policies or laws that change what	Describes a new or existing	Describes policies related	Source: Chapter 3	"You know, Boston is super advanced in terms

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
Socioecological context		actions people might be allowed to take or are supported in taking	policy that changes what kinds of opportunities people may participate in (e.g., zoning codes)	to racial or economic discrimination (e.g., redlining); describes a new policy that was developed to change behavior related to adaptation		of their planning and they're, they have a great program. It's pretty well funded at the city level. They have a really robust plan."
Contextual factors: Socioecological context	Existing public concern about climate change	Stated level of public concern about climate change and its impacts	Describing broad impression of community attitudes toward climate change	An individual's belief or disbelief in whether climate change is occurring	Source: Chapter 3	"M: How concerned would you say is the general public about climate change in your community? R: Um … climate change specifically? I mean, I'd say it's a factor, but it's not the overarching concern. I think … I think people, the primary concerns are exacerbated by climate change."
Contextual factors: Socioecological context	Historical natural events	A local event in the past where community members experienced a sudden natural change or disaster	Local events related to natural causes such as floods, earthquakes, hurricanes, etc.	Local events related to non-natural causes such as loss of an economic resource (e.g., a factory left town, industrial accidents)	Source: Chapter 3	"In the [CITY] community, hail in particular has caused quite a bit of damage, [with] multiple events with large-dollar impacts in the last couple of years."

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
Contextual factors: Socioecological context	Historical non-natural events	A local event in the past where community members experienced a non-natural change or disaster	Local events related to non-natural causes such as loss of an economic resource (e.g., a factory left town, industrial accidents)	Local events related to natural causes such as floods, earthquakes, hurricanes, etc.	Source: Chapter 3	"In [CITY], which basically funnels the wastewater and sewage into the same tunnel. … It can back up into people's homes, so that's actually happened in a couple of neighborhoods before."
Contextual factors: Socioecological context	Location and existing environmental risk	Factors that might put individuals or households at greater risk depending on their location	Location of housing in, e.g., a floodplain or fire risk zone; specific risks to a geographic area	Climate change impacts that are not location-specific	Emergent code	"People who live in close proximity to flood plains. Mostly flood plains are on the east side of [CITY]"
Contextual factors: Socioecological context	Racial inequality	Community-level factors related to how racial discrimination might affect climate impacts people experience or the actions they might take	Describes historical or social problems related to racial inequality (e.g., redlining, racism)	Describes historical or social problems related to economic inequality (e.g., inadequate affordable housing)	Emergent code	"The situation that a lot of people are in right now is not because they chose that situation or they can't get out of it, it's because that is what our structural and institutional racist policies created and are being implemented in our communities."
Contextual factors: Socioecological context	Social inequality (general)	Describes social inequality problems but does not describe a specific type of inequality (e.g., "underrepresentation,"	Implicitly or explicitly describes differences in groups but not what types of groups	Describes inequality related to racial or economic factors	Emergent code	"So we've always had, we've had a historic emphasis on under-representation as a priority within our grants program."

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		"differences in groups")				
Outcomes	Community benefits	Short- or medium-term benefits to a community beyond immediate protection from adverse events	Improvements to infrastructure or shared built environment; improvements to collective well-being	Long-term changes like increased equity, justice, etc.	Source: Chapter 2	"So the outcome is a more confident, educated, and engaged community"
Outcomes	Environmental benefits	Changes to ecosystems or environmental quality as a result of actions taken	Environmental improvements such as improved air quality, increased biodiversity, etc.	Improvements to infrastructure or built environment	Source: Chapter 2	"drainage becomes less of a problem"
Outcomes	Financial savings	Saving money for oneself as a result of actions taken	Describes saving money due to reduced bills, reduced repair costs, etc.	Describes absence of property damage or personal damage, etc. without mentioning cost savings	Source: Chapter 2	"getting their houses retrofitted so that they don't have high energy bills"
Outcomes	Mental health	Psychological well-being; being able to psychologically function as a result of actions taken	Well-being as an outcome of coping or other activities	Actions to manage stress or promote mental health, alone or with others	Source: Chapter 2	"We commissioned a study … to quantify the benefits of [hazard] mitigation in preventing PTSD and other mental stress."
Outcomes	Personal safety	Maintaining safety for oneself and one's household during an	Describes an absence of damage from an	Describes general health	Source: Chapter 2	"That's kind of a big piece of doing the work with residents is how

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		adverse event as a result of actions taken	event, may also include absence of property damage	or lack of injuries		can they protect themselves."
Outcomes	Physical health	Physical well-being, absence of injury or illness, being able to perform one's usual physical tasks as a result of actions taken	Describes physical dimensions of well-being	Describes an absence of personal damage or property damage from an event	Source: Chapter 2	"Love to see the number of heat-related illnesses decline"
Outcomes	Policy change	Changes to specific laws or policies as a result of actions taken	Names a specific policy, type of policy, or law	Describe long-term changes like increased equity, justice, etc.	Source: Chapter 2	"We tend to push more for [hazard] mitigation plans, for building codes"
Outcomes	Prioritizing outcomes	Interviewee mentions differentiating in importance between multiple outcomes	Describes how a specific outcome is more or less important than another	Describes an outcome but not its importance relative to other desired outcomes	Emergent code	"I feel like that is generally, probably a tangential -- ah, not tangential -- more of a secondary, tertiary, sort of benefit."
Outcomes	Social change	Changes in broader social structures and norms as a result of actions taken	Long-term changes like increased equity, justice, etc.	Names a specific policy, type of policy, or law	Source: Chapter 2	"Shifting power needs to happen, and that that's our focus."
Outcomes	Other outcomes	Outcomes that do not fit into any other existing category	Outcomes that do not fit an existing category	Outcomes that do fit an existing category	Emergent code	"We tend to look at more traditional education gains as our outcomes."
Psychosocial antecedents	(Mis)trust in government	Belief or disbelief in the reliability and truthfulness of government	Describes community members' belief in whether	Criticism of government or policy itself; description of	Source: van Valkengoed & Steg, 2019a	"People have enough conspiracy theories about [AGENCY] that

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
			government is doing what it claims to do	mis/trust in other organizations		we don't want to be big government"
Psychosocial antecedents	(Mis)trust in implemented measures	Belief or disbelief in the reliability of existing adaptation measures	Describes community members' belief that a specific program or intervention will do what it claims to do	Description of mis/trust in government or other organizations	Source: van Valkengoed & Steg, 2019a	"It took a lot of trust building with the community to say, 'We're not just trying to kick you out of your house, we're trying to reduce risk and improve safety in our community.'"
Psychosocial antecedents	(Mis)trust in other people	Belief or disbelief in the reliability and truthfulness of other community members or organizations not captured elsewhere	Describes specific people or organizations trusted or mistrusted in the community	Describes engagement practices without mentioning trust issues	Emergent code	"Definitely partnering with community-based organizations and trusted community allies is really, really critical stuff in our engagement process."
Psychosocial antecedents	Climate change belief	Personal belief that climate changes is happening and is attributable to human activity	Describes how individuals' belief in climate change affects their behavior	Describes general public concern about climate change	Source: van Valkengoed & Steg, 2019a	"A lot of these guys are from far southwestern [STATE] where we have the lowest agreement with statements like 'Global warming is happening,' 'CO2 is the main cause,' those sorts of things."
Psychosocial antecedents	Descriptive norms	Unwritten rules of behavior among a group of people reflecting how people actually behave	Describing how people respond to what they see other people doing	Describing how people respond to what they are told to do	Source: van Valkengoed & Steg, 2019a	"It's like a tribal mentality, right? If the people that you're surrounded by aren't mindful or if they aren't

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
						prioritizing climate change or if they're not changing their behavior in response to climate change, then you might not either."
Contextual factors: Socioecological context	Differences in spoken language	Differences in spoken (verbal) languages that make communication difficult	Describes how different groups of people may speak different languages	Describes challenges in reaching particular groups of people or that people think about a problem differently	Emergent code	"So with our school districts over 90 first languages are spoken in [CITY] alone. So when there is an emergency, for example, when we had the November 30th earthquake, we had, there were notices put out that said "boil your water," well we we've got to put those out in many different languages."
Psychosocial antecedents	Experience	Personal experience with a climate change impact	Describes how a person's experience with a climate change impact might influence their future perception or behavior	Describes a climate change impact without linking it to personal experience or perception	Source: van Valkengoed & Steg, 2019a	"And we're also seeing a series of natural disasters that's really hitting this whole issue home for a lot of people."
Psychosocial antecedents	Injunctive norms	Unwritten rules of behavior demonstrating desired behaviors among a group of people; may	Describes how people respond to what they are being told to do	Describes how people respond to what they see the people	Source: van Valkengoed & Steg, 2019a	"We've had a lot of conversations with people where they're like, 'Look, I would rather sit and sweat in

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		or may not be the same as what people are actually doing		around them doing		my house even with my elderly parent or something than go down to a cooling center.'"
Psychosocial antecedents	Knowledge (awareness)	Being aware of how climate change might impact oneself	Describes knowledge and awareness of climate change impacts	Describes attitudes toward whether climate change is happening	Source: van Valkengoed & Steg, 2019a	"I think in some of the workshops that we've done, it has definitely made climate change more understandable and how it will impact individuals' lives that people haven't thought about. I mean, they don't think about global warming on a day to day basis."
Psychosocial antecedents	Negative affect	Negative emotions regarding climate change, including guilt or fear	General or specific negative emotional reactions (upset, worried, angry)	Describes attitudinal or knowledge factors e.g., belief in climate change	Source: van Valkengoed & Steg, 2019a	"We've used it as part of our communications … to help them have a more emotional, visceral reaction to flood risk."
Psychosocial antecedents	Outcome efficacy	Personal assessment that one's actions will make a difference in addressing an issue	Describes a sense of belief that one's actions make a difference in addressing a specific issue or impact	Describes a general sense of empowerment or agency	Source: van Valkengoed & Steg, 2019a	N/A
Psychosocial antecedents	Place attachment	Personal importance attributed to a place	Wanting to protect or stay in a specific place	Experiences in a place; attachment to	Source: van Valkengoed	"I think definitely in terms of like more rural forested lands, I think a

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			because that place has personal value	other people regardless of place	& Steg, 2019a	really strong asset is like the sense of connection to the landscape and feeling and responsible – or not responsible, but compelled – to just to help that landscape become more resilient."
Psychosocial antecedents	Pro-environmental attitudes and climate change concern	Personal level of concern about environmental issues generally or climate change specifically	Being concerned about environmental issues	Belief in whether climate change is happening; emotional responses to information about climate change	Emergent code	"I think probably you can generically identify those people that are sustainability-minded, but that's such a loose term."
Psychosocial antecedents	Responsibility	Personal sense of obligation to act	Wanting or feeling obligated to act, acting on behalf of other people; may also include a perception that other people should act (i.e., ascription of responsibility)	Acting in the way one has been told to act	Source: van Valkengoed & Steg, 2019a	"We want people to take ownership and their own power, into their own hands. And so in that it's not just saying 'oh, the hub is here for me to give me things.' But 'how am I actively engaging as a community member in my hub? What am I doing to support my community?'"
Psychosocial antecedents	Risk perception	Personal belief that a climate change event poses a risk to oneself	Personal assessment that climate change	Belief that climate change is or is not	Source: van Valkengoed	"I think even though folks kind of experience some of the catastrophic

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		or one's household; could also be called "threat perception"	is or is not a threat; perception of when and how climate change will affect oneself and how that affects personal behavior	happening; self-assessed ability to respond	& Steg, 2019a	impacts of climate change firsthand and directly, it's ... it's hard to say whether that's having a direct impact on their own level of perception of risk and if that's leading to any changes in behavior."
Psychosocial antecedents	Self-efficacy	Personal assessment that one can take action that addresses an issue at hand	Empowerment; agency; belief in oneself and one's ability to exert control over a situation	Belief that one's actions will address a specific problem; knowledge of what to do in a specific situation	Source: van Valkengoed & Steg, 2019a	"it was empowering in like a really genuine way"
Psychosocial antecedents	Skills	Having knowledge or trainable skills that enable a person to take on certain behaviors; includes procedural knowledge	Knowledge of what to do in a specific situation; generalized skills related to responding to climate impacts	Knowledge about climate change science or awareness of climate impacts	Emergent code	"Maybe a different set of skills than that group would otherwise have."
Psychosocial antecedents	Social connectedness	Feeling of connection with other people	Closeness to other people; protection of other people; individuals' feeling of	Connection to a place independent of the people in it; group cohesion or support without	Source: Wilson et al., 2020	"One is something that really resonates with people in like a really tangible way, their own children, right? Or grandchildren or

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			community with other people	discussing individuals		neighbors, that's not far-off, that's a real thing."
Psychosocial antecedents	Stress	Mental or emotional strain or tension resulting from adverse or demanding circumstances	Stress related to climate events or general life stress	Negative emotions such as anger, sadness, or worry; pre-existing or resulting mental health or trauma	Source: Doherty & Clayton 2011	"Whenever we talk about floods, people always talk about PTSD. And they always mention that, whenever there's a rainstorm coming, people start to get really stressed out."
Psychosocial antecedents	Other motivators	Other psychosocial antecedents that might relate to behavior	Describes factors that do not fit into other categories	Factors that do fit into other existing categories	Emergent code	"And then there's this cohort of people, at least in [CITY], who just want to be part of something because it's a great resume booster and helps them with their next interview."
Intervention	Community building activities	Activities to bring people in a community together	Community events, volunteer groups, resilience circles, group problem-solving	Research partnerships between universities and community members; changes in government decision-making structures	Source: Chapter 3	"resident-led neighborhood-based projects"
Intervention	Community research partnerships	Research partnerships where experts work with community members to collaboratively	Citizen science, action research, and community-based	Community events, volunteer groups, other projects that do	Source: Chapter 3	"She probably interviewed 20, 30 people in the city, and then 20, 30 people in the community,

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		understand and address a local issue	participatory research	not involve a data collection component		community leaders and community members. And after three months she presented it back to assistant city managers."
Intervention	Educational programming	Teach skills or develop in-depth knowledge, usually in an in-depth and interactive setting	Multiday meetings, workshops, interactive meetings, formal courses, informal education, or interpretation	Single presentations, informational handouts, virtual reality experiences, citizen science, action research	Source: Chapter 3	"That turned into a whole series of workshops on how to actually maintain your property and your yard without using chemicals, different techniques, and that led to then a whole nother project was identifying where you could even source plants, and chemistry 101 on some of the alternative materials."
Intervention	Financial support	Offering financial benefits (e.g., rebates, discounts) for taking a particular action	Incentives, buyouts, discounts, rebates, payment for participation	Information, changes to legislation	Source: Chapter 3	"There's a subsidy for green roofs, for new buildings"
Intervention	Framing issues	Discussion of how organizations frame information when communicating to different groups (e.g., do they frame around certain issues or use	Discussion of how communications or engagement strategies are framed to emphasize certain aspects	Discussions of which aspects of climate change are most important to specific groups but not how it	Emergent code	"We always start off with what are your assets, then what are your concerns, and then we tie those assets back to climate as opposed to the other way around."

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
		positive/negative framing)	of climate change that are most important to different groups	relates to communications		
Intervention	Information provision	Provide specific information about actions and/or general information about problems	Virtual reality simulations, media and advertisements, presentations, informational handouts	Educational programs, interpretation, action research	Source: Chapter 3	"Outreach materials, our email templates, our flyers and everything… We've also done, we've also postered as well. So going out directly into the community and putting posters up at community centers and you know, publicly where, where possible."
Intervention	Infrastructure change: Physical infrastructure	Changes in physical structures such as buildings or roadways	Green infrastructure, new installations, emergency structures, parks, and land use change	Collaborative planning, policy, or legislative change	Source: Chapter 3	"Rain gardens at the community scale and on private property"
Intervention	Infrastructure change: Non-physical infrastructure	Changes in information that affects future operations	Hazard mapping, non-collaborative planning, organizational (non-public) partnerships	Roadways and land use change, collaborative planning, policy change	Emergent code	"flood mapping"
Intervention	Institutional structure change	Changes in how a local government	Collaborative planning,	Policy or legislative	Source: Chapter 3	"So a lot of our work is actually mostly focused

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		involves the general public in decision-making	collaborative decision-making, community-based adaptation	change, community-based participatory research		on gathering input on the needs and concerns from the community to then work with public agencies and other partners to integrate that as part of their planning process or the implementation process"
Intervention	Policy change	Changes in laws or regulations	Changes to policies that might affect what kinds of actions people might carry out (e.g., zoning,	Changes in decision-making structures such as collaborative planning	Source: Chapter 3	"We need to be doing this, like all sorts of policies in all sorts of different ways"
Intervention	Product or technology availability	Changes in what kinds of products or technologies are available for individuals to use to respond to climate change impacts	Food provision, providing equipment for emergency kits, development of new technologies, disaster relief and humanitarian aid	Rebates, buyouts, or other financial support to obtain products	Source: Chapter 3	"For those who participated in the workshops where they actually got to make their bug-out bag, we have those materials to take that home with them. Weather radio, and all those."
Intervention	Psychological support	Therapeutic support for individuals (could be individual or groups)	Support groups, therapeutic techniques, one-on-one therapy, coping strategies that are taught	Community events, information sharing, educational events	Source: Chapter 3	"So what that means is that for some of my clients, I'm praying with them in session … we co-create or it may be rituals that they've already been doing."

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
Thematic codes	Conceptualizing behavior differently	Interviewee expresses a different way of conceptualizing "behavior" in the context of adaptation	Describes behaviors as irrelevant to adaptation, describes behaviors only as actions that individuals take to conserve energy or benefit the environment	Describes actions that have both adaptation and mitigation benefits	Emergent code	"We did all of those things and we taught our children, who now just assume recycling, it's just what you do. You turn out the lights. They'd never turned out their lights, their electricity was dirt cheap. And so there's a limit to how much you could do individually."
Thematic codes	Funding challenges	Challenges related to obtaining needed funding for programs	Describes challenges related to obtaining needed or appropriate funding; how the practitioner does (or does not) navigate those challenges	Challenges related to political support for or opposition to programs	Emergent code	"Well, the biggest problem is, is, you know, funding comes from council, usually not enough for what they need."
Thematic codes	Interviewee doesn't know or can't answer question	Interviewee indicates in their response that they do not know or cannot answer a specific question	Interviewee says "I don't know" in response to a question	Interviewee is able to answer question (regardless of how well they answer the question)	Emergent code	"M: Are there buyout programs that you know of or are working with that are looking at [anticipated] flooding in addition to like those disaster extreme event flooding programs? R: Um, I don't know. There probably are, and they may also be done

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
						under other funding models, like those in Miami, right? But I don't know of any real examples of that."
Thematic codes	Political challenges	Political pressures on the practitioner that affect their job or programming	Challenges related to political support for or opposition to programs; how the practitioner does (or does not) navigate those challenges	Challenges related to obtaining needed or appropriate funding	Emergent code	"What I fear will happen is this administration is done in two years where it [inaudible] termed out and, uh, you know, if people vote the other way, and so, well, we could be very easily sued."
Thematic codes	Presence/absence of leadership or champions	Discusses a certain person or group of people who encourage or inspire others to take action regarding climate change	Names a specific person or group of people who have inspired or encouraged action, or a need for such a person	Describes these kinds of feelings without naming a specific person or group who inspires them	Emergent code	"Youth as a direct audience, is, is uh, an incredibly powerful audience. … They punch way above their weight, and they're not waiting to be the leaders of the future on this issue, right? They are calling community leaders of all sorts and all scales to really do the things that need to be done."
Thematic codes	Program background	Information about the program itself, its operation, and its history	How long a program has existed, number of participants, number of staff,	Information about political and funding challenges,	Emergent code	"We were a big partner on the Kresge climate resilience and urban opportunity grant, so 17 cities got that, but it was

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
			funding sources, participant recruitment strategies, etc.	program design logic		basically a place-based organization that received the funds, was the lead and we were a big support. So [LOCAL ORGANIZATION] did that. We focused in 4 neighborhoods on that grant that's finishing up now."
Thematic codes	Short- versus long-term adaptation	Interviewee distinguishes (or clearly does not distinguish) time scales of adaptation	Discussion of time scales, short-term versus long-term adaptation, emergency preparedness vs. long-term adaptation	Discussion of geographic scales, discussion of adaptation without comparison of specific time scales	Emergent code	"It's about thinking long term. [Hazard] mitigation programs as supported by the federal government for years have been about short-term solutions, and to an extent, still are."
Thematic codes	Other important insights and best practices	Other notable ideas that come up that are worth talking about – these might be developed into future codes			Emergent code	"So one of the things we're looking at is using all of these advances in theories and understanding, because when you have a community that's doing deep climate action, if you don't have a boundary organization, a backbone function, [and see] collaboration, building common agendas, you're not

Category	Code	Definition	Inclusion Criteria	Exclusion Criteria	Notes	Example Quote
						going to get the collective impact you need.”

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